THE

YOUNG FARMER'S MANUAL:

OR,

HOW TO MAKE FARMING PAY,

GIVING PLAIN AND PRACTICAL DETAILS OF GENERAL FARM MANAGEMENT;

WITH

A CHAPTER ON SOILS,

AND THEIR CULTIVATION,

AND MUCH OTHER VALUABLE MATTER OF A PRACTICAL CHARACTER.

BY

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VOLUME II.

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PREFACE TO VOLUME SECOND.

THE first volume of "THE YOUNG FARMER'S MANUAL" treats of Mechanical Agriculture, and should be read with this, as it is intimately connected with it. The first chapter of this volume is made up of brief articles on the General Management of the Farm. The chapters on Soils, Pulverization, and Fertilizers, are as brief as they can be, in order to give a *young* farmer a thorough understanding of that branch of agriculture. A good knowledge of these branches lies at the very foundation of a good system of Farming.

My first volume was written while I lived on a farm near Lake Ridge, Tompkins County, N. Y., where I was born, and resided until I was forty years of age. From Lake Ridge I removed to Auburn, N. Y. In the former part of 1865, I moved my family to New York City. Read the Preface to Volume I.

I have endeavored to reduce the "scientific" to practice; and I think no intelligent reader will fail, with a dictionary, to get a correct idea on every subject, as I have aimed at simplicity of style.

The instructions of this volume will be found well adapted to any portion of the United States and Canada, and even to European agriculture.

Many of the paragraphs of this book were originally written for the "Country Gentleman," "Boston Cultivator," and "American Agriculturist," and a number of the illustrations are from stereotypes of wood-cuts prepared for the "American Agriculturist." The articles alluded to have been revised, and sometimes improved, previous to being arranged for this volume.

One prominent object, which I have aimed at, is, to pen good practice, good experience, and good details for performing the labors of the farm, and cultivating the soil, so that young farmers will not be required to spend a whole lifetime in reaching a given point in Agriculture, to which multitudes have already attained; and that they may be able to make the highest point of good farming *their starting place.* If this object can be accomplished, my highest aspirations will be satisfied.

I have written independently of the writings of other men. My aim has been to give my own experience, in preference to any thing that has ever been published. In this respect, this volume is an original work. After having penned my own thoughts, I have examined a very few agricultural journals for the purpose of copying the remarks of the best writers on the same subject. Whenever I have copied a paragraph, proper credit has been given, if the authority were known.

The manner in which subjects are described in the first chapter, as well as the style of composition, will furnish a forcible illustration of prosecuting the labors of a farm, even when the operations are well conducted, both in the field, in the management of stock, and of fertilizers. My ideas have been written in such a manner, that the reader will perceive more or less confusion in the few first pages. The design of employing certain rhetorical figures of speech and bombastic language was, to in-

tensify the ridiculous feeling which prevails with some persons when they reflect on the truths to which I have made allusion.

If some paragraphs appear too common-place and lacking in dignity, I have only to reply to such a thought that I have not written for persons of refined manners and polished education, but for *working and uneducated farmers*, who need the greatest plainness and simplicity of speech, smacking sometimes of slang, for the purpose of bringing the thought home to the reader in the most emphatic manner.

The reader may inquire what connection killing weeds and plowing and harrowing has with "making farming pay?" These subjects lie at the very foundation of good agriculture. If a man does not know how to plow well, nor how to exterminate noxious weeds, he does not understand the fundamental principles of his profession. If the reader will study the different subjects alluded to in this and the next volume, so as to understand them thoroughly, he will be well prepared to make farming pay.

S. E. T.

NEW YORK, 1867.

THE

YOUNG FARMER'S MANUAL.

VOLUME II.

CHAPTER I.—INTRODUCTION.

GENERAL MANAGEMENT OF A FARM.

"Work, for the night is coming;
Work, through the morning hours;
Work, when the dew is sparkling,
Work, 'mid springing flowers."

1. A FARMER'S destiny is to labor with his hands. To facilitate his labors, and enable him to succeed in his employment, he needs *facts*. The minds of the great mass of working men have not been enlightened by scientific knowledge. For this reason, they are not properly qualified to avail themselves of the advantages to be derived from instructions that are more theoretical than practical. A well-established fact will overthrow the most plausible theory. In the management of all kinds of domestic animals, in the cultivation of the soil, in raising the various products of the farm, facts, figures, and plain details of whatever is to be done, is always of primary importance. Farmers are required to understand such a variety of manual labor, that they often need minute details to enable them to perform what sometimes appears so simple as to need no explanation. Knowing that success depends on the general management of farming operations, my aim is to aid practical men in beginning correctly and ending successfully.

AGRICULTURAL CHEMISTRY.

2. Only a few years ago, many good writers on agricultural subjects were aiming *to lead* practical agriculture, by vision-

ary theories in the cultivation of the soil, and in the production of various kinds of crops. But I am sorry to record that the details of Agricultural Chemistry, after having been brought to bear upon the principles and practices of field operations, have brought *disappointment*, in most instances, instead of encouragement and success.

I would not decry Agricultural Chemistry. I would accredit to that science all that is really due to its investigations. But the manner in which Agricultural Chemistry has been extolled, in years past, has had a great tendency to bring not only that science, but the science of practical agriculture, into great disrepute, by those who are anxious inquirers after truths and facts, that have an important influence on the successful cultivation of the soil and on the revenue of the farmer. It has been a source of pleasing satisfaction to intelligent farmers to read the reports of chemical investigations; but, when the young farmer—or the old one either—has endeavored to avail himself of some of the practical benefits to be derived from agricultural chemistry, he has found that in most instances he has been pursuing a shadow, and has attempted to grasp a phantom. It is true that chemical investigation has taught farmers the importance of saving bones, and how to reduce them to a fine condition with sulphuric acid, so that they may be employed as valuable fertilizers in promoting the growth and fructification of plants. But when we come to make an application of chemical science to the improvement of our agriculture, by following the details given by writers on Agricultural Chemistry, we learn that dissolving bones with acid is an improvement that has been overrated; because the *expense* which must be incurred will be too great to justify practical farmers in adopting such a system of fertilization.

3. Agricultural Chemistry has taught us in what particular ingredient some soils are deficient for raising a certain kind of grain. But when we have come to mingle those ingredients with the soil in which it was said to be deficient, as a general rule it has been found that there is something more lacking. We have reason to hope that, in view of the investigations of Agricultural

Chemistry, the time will come, ere long, when we shall witness grand instances of the application of chemical science to the improvement of the agriculture of our country. When farmers of ordinary intelligence can avail themselves of the benefit of chemical investigations, so as to turn them to a profitable account in their systems of farm management, *then* Agricultural Chemistry may boast of her great and valuable service in improving the fertility of our soils, and of making them more productive from year to year.

MECHANICAL AND CHEMICAL—THEORY AND PRACTICE.

4. Farmers should understand the difference between *theory and practice,* as well as between *mechanical and chemical.* When iron or bones are dissolved by acid, the action is *chemical;* but when broken with hammers, or cut with chisels, it is done *mechanically.* Plowing, harrowing, and rolling the soil, are all *mechanical* operations; but the changes which take place in the soil, in the formation of vegetable mould, and production of plants, are chemical. When wood is cut to sawdust, it is done *mechanically;* when burned to ashes, chemically.

5. "Theory," the swift-winged sister of "Practice," ever vigilant and active, launches off into new and unexplored fields of thought and investigation; and beckons impatiently for her twin sister "Practice" to follow with hasty steps where she has led the way. But "Practice," unobtrusive, economical and discreet, refuses to move. "Theory" then returns, and upbraids "Practice" for her inefficiency and tardiness, who meekly replies, the way was long and beset with many insurmountable barriers. "Theory" on the impulse of a hasty moment, switches off on a new-fangled enterprise, and visits the isles of the ocean for guano, the bone mills for ossiferous fertilizers, the laboratory for a demijohn of acid; and then, with a barrel of poudrette, with a sack of superphosphate, with a pocketful of lime, and a handful of gypsum, she prepares the soil with silver-tipped implements, and makes it fertile with the choicest elements of fertility, while pleas-

ing anticipations of a fabulous crop fill her mind. But "Practice," always contented and never fretful, saves all the droppings and liquid of the stable and piggery, silently flattering herself that, if her crop is not as abundant as that of her sister, there will be enough to pay the expense incurred in cultivation, and a little more.

6. After the crops have been secured, disconsolate "Theory" says to "Practice": "Lend me ten picayunes to pay for my demijohn of acid, for my crop was almost a failure." Gentle "Practice" kindly replies: "Let my sister take *twenty* picayunes; for *my* crop, which only received the benefit of the droppings of old Bos, Cherry, and gentle Dick, was very bountiful."

7. Again, energetic "Theory" circumnavigates the globe, and plucks a fair head of wheat on the shores of the Black Sea, an ear of barley on the banks of the Nile, a panicle of choice oats from the fertile plains of California, and a pocketful of garden seeds from China. Then, with her fancy steeds and silver-mounted implements of husbandry, she cheers the heart of her sister "Practice" with the promise that her picayunes will soon be all returned with good interest. But PRACTICE continues to move steadily forward in her daily labors, *performing every thing in good time and in good order*, and wasting nothing. She selects the fairest and earliest ears of grain; and the first ripened seed of the garden is carefully stored for a future crop. At the end of the growing season, THEORY takes up with the lamentation of blasted hopes and disappointed anticipations; while PRACTICE rejoices in a complete realization of all her anticipations. Every young farmer should learn from these considerations to "count the cost" in every enterprise. If he should be prompted to attempt to raise a large crop of anything, by expending far more than it would be worth after it was raised, it would not be in keeping with a judicious system of management, even if one should have an abundance of means for such a purpose.

8. I do not condemn theorizing, as such; for without good theorizing we could have no good practice in the cultivation of the soil. Neither do I approve of holding and advocating theories, in agriculture, which cannot be successfully and profitably carried out. But the two should be coupled

together, and made to keep pace with each other, in all important improvements. If THEORY makes valuable or wild suggestions, PRACTICE must decide whether they will be feasible, practicable, and profitable, or not.

ANALYZING SOILS AND PLANTS.

9. A great many young farmers cherish the erroneous notion that if they only knew how to analyze soils and plants, it would be an easy matter to render a soil productive. And a great many wise heads have even contended that a knowledge adequate to such an operation is indispensably necessary for every successful farmer. But we find that such analyses do not amount to any practical utility whatever. A farmer must possess something else besides analyses of soils in order to be able to manage them so as to produce abundant crops. I have in mind an instance in which one of the very best wheat growers of the Empire State selected specimens of soil from several different places in his best field for raising wheat, which would, at that time, yield from thirty to forty bushels of wheat per acre. The soil was carefully analyzed by an eminent agricultural chemist, and pronounced to be deficient in those elements of fertility necessary to form a good soil for wheat.

10. Are we to suppose, for example, that a chemist will be able to detect, in his laboratory, the fertilizing influence of the infinitesimally small quantity of gypsum that falls on a square foot of ground, when only one or two bushels per acre are sown, which will produce a heavy crop of clover? And, the same is substantially true of the analyses of various kinds of plants and grain. Again, how much of the aroma of sweet-smelling hay are we to suppose can be detected in the laboratory of a chemist by a careful analysis of a few pounds of the choicest quality of hay? There may be some little satisfaction in reading about the chemical constituents of various kinds of plants and grain, but in the practical operations of the farm they will afford little aid. A correspondent of the *New York Agriculturist* wrote to the Editor that he thought it would interest other readers, as well

as himself, to have tables published, which would show the chemical constituents of different kinds of farm produce, so that the farmer, by having his soil analyzed, could raise in rotation that class of plants best suited to the soil.

11. The "Theory" on this point, at first appearance, seems to be just what farmers need. But we find that in "Practice" there is a certain something lacking. For we cannot make the "Theory" and "Practice" coincide so as to effect the desired results. There are plenty of tables of this kind, such as they are. Johnston's Agricultural Chemistry is full of them. Ten or twelve years ago a distinguished agricultural chemist prepared a large chart, closely packed with these kinds of analyses, which are now esteemed of little *practical* value. By the aid of chemistry, we are able to know to within a hundredth part of a grain the composition of soils and their products, yet we can make little use of this knowledge. For example, we know that the ashes of wheat contain a large amount of phosphoric acid, and turnips but little; yet an application of phosphates to the soil does very little good to wheat crops, while the superphosphates are *the* great turnip manure in England.

NO PRACTICAL UTILITY IN ANALYSES.

12. The *Country Gentleman* says on this subject: "To analyze a soil with sufficient accuracy to render the analysis of any value, requires a chemical education, and considerable apparatus, just as a physician needs an education for his profession, and a large variety of drugs from which his medicines may be compounded. And the great difficulty, after a proper analysis is made, is this—that so many influences, the effect of which the chemist cannot estimate, arise, in farm cultivation, to increase or diminish the fertility of the soil. Thus, when its mechanical texture is just right, when the presence of moisture is regulated by good natural or artificial drainage, and when proper attention turns the whole productive power of the soil to the crop upon it, instead of giving a large area to weeds, a small per centage of those ingredients most sought for by the plant will go much farther than an equal or considerable larger per centage of the same ele-

ments under contrary conditions. There may be some points that the chemist can prove by analysis, such as the cases of poisonous materials, if added in large quantities; but, as a general rule, analysis of the soil is now discarded almost wholly as a practical guide in farming. It is of very great importance in scientific investigations; but even in such plain matters as endeavoring to decide whether a soil requires liming or not, by testing the quantity of lime it contains, we fancy the money an analysis would cost will go much farther, and impart more satisfaction, if expended in experimenting with lime itself.

13. The truth is, that all soils, with rare exceptions, contain enough of the ingredients of the crops we cultivate, so far as mere *quantity* is concerned, to produce these crops year after year to an almost unlimited extent. The difference in soils arises, therefore, from the different degrees of availability in which their constituents are present, rather than in the relative quantities. When a soil is said to be "exhausted," we by no means imply that the food of plants is no longer present; but that it is not present in such a way that the plant can readily get at it. Thus, a fallow for one or more years may add greatly to the productiveness of a field, while nothing has really been added in its composition; and analyses before and after the fallow would be just alike.

PROGRESSIVE AGRICULTURE.

14. The present is an age of improvement. The minds of all good farmers are being turned to the subject of better stock, and more abundant crops, from year to year, without incurring any unnecessary expense in the labors of the farmer. Their minds are grasping for a system of farm management that will be *self-sustaining;* a system that will not only *keep* the soil in a good state of fertility, but render it more productive from year to year; a system of management that will soon be the means of producing two blades of grass, two bushels of grain, two pounds of wool, or meat, with no increase of expense, where at the present time the proprietor receives only one.

15. Our fields do not produce one-half the amount of grain, grass and meat that they are capable of producing under proper management. At present there can be found but a few instances, in our entire country, where the productiveness of a farm has been tested to its fullest capacity. Some farmers have experimented, and made efforts to improve the productiveness of their farms for a number of years in close succession; and every year, with no extra labor, their crops have proved to be a little more abundant. In numerous instances, impoverished and worn-out farms have been brought to an excellent state of productiveness, with no other available resources for effecting this object than what was found in the soil and on the farm.

16. This, then, is what may be denominated *progressive agriculture*. That system of management which will make a poor farm a good one, and render a good one more and more productive from year to year, will be the system advocated in the following pages. The time is coming when the details of our farm management will be ridiculed and discarded, and when we shall see abundant crops of golden grain and grass where now those crops barely pay the expense of cultivation. And an object so desirable will be attained by investigation, by careful experiments, and by the application of scientific and practical knowledge. This work is already begun; and we are satisfied to be permitted to have wrought as a pioneer in an enterprise which will, eventually, render the world wiser and happier, and mankind better.

17. When the agriculture of our country is characterized by that *system* of judicious management which will eventually prevail—when our soils shall have been underdrained as they ought to be—when they shall be improved in fertility by manuring and more complete pulverization—when our farmers have learned how to save—to make—and to apply manure in the most profitable manner—and when they have learned to turn their grain into meat which will be worth as much as the grain, while the manure of the animals fed will increase the amount of the next crop nearly two-fold—then we may not only reckon on our agri-

culture as being *progressive*, but as a system of farming that "will pay," and be worthy of universal adoption.

PAYING FARMING.

18. Farming may pay well in one sense, and at the same time be characterised by an injudicious system of management. Farming may pay well, in one sense, and still be of a *retrogressive* character. It may pay well the expense of cultivation for a number of years in succession, and at the same time be a system of management that is continually impoverishing the soil and rendering it less and less productive. Therefore if we have the assurance that farming pays well, we have no assurance at all that the system of management which has been adopted is a good one, and worthy of recommendation. If a system of farm management be so much of a *progressive* character that it may be said to pay, then it will be consistent for us to speak of it as paying farming.

19. Thousands upon thousands of farmers in America are growing rich by raising grain, cattle, beef, mutton, and pork; and they are called good farmers. But the truth is, their practices will eventually ruin their soil; because their system of agriculture is not of a progressive character. The time has already come in the New England and in the Middle States—and it is fast approaching in the fertile and productive States of the West—when it may be said of thousands of acres of the choicest land of the country, that it has been so impoverished by a bad system of farm management, the proprietors will not be able to pay the interest on the land and the expense of cultivation from the products of their soil. But if those who may succeed them will at once adopt a renovating system, and take suitable measures to restore the impoverished soils of our country, we may yet have the pleasure of seeing a progressive system of agriculture where it is now decidedly bad. One of the first considerations in making improvements in any enterprise is, to obtain a correct idea of its imperfections.

WHAT CONSTITUTES PAYING FARMING?

20. There is a vast deal written and said, at the present day, about "paying farming," or "farming that pays." But not one half of those who talk and write upon the subject have any correct *practical* notions of it. "Paying farming" is not that system of management which returns to the possessor the largest crops and the greatest percentage on the capital invested. We often hear it remarked that such a man is a good farmer because "he makes farming pay." See how well his farm is fenced, and everything in prime order. But paying farming does not consist in good fences, any more than it does in good and substantial buildings, and in beautiful yards and ornamental grounds. Indeed, good or poor fences and buildings have so little to do with paying farming that they cannot, with much propriety, be considered any sure index, either one way or the other, as pointing out correctly a paying or non-paying system of management. Some of the best farmers of the country are allowing their fences to go to dilapidation and ruin and to utter disuse; because the expense of erecting and keeping suitable fences in repair consumes more of the profits than would be incurred by that system of management in which fences are entirely dispensed with.

21. Again, we hear it often repeated, that such a man is a good farmer, for he always seems to raise good crops, and to make money very fast. There are scores of farmers in our country, who are extolled as very excellent farmers, who, if they were placed without a large pocketful of cash on many farms, where farming pays well, would soon become insolvent, and be obliged to sell their farms to keep them from starvation. He who produces a large crop of anything, by expending large sums of money for foreign manure and for unnecessary cultivation, although he may receive the appellation of a good and thorough cultivator of the soil, cannot be called a good farmer; nor can such a system of management be consistently called "paying farming." As important and as desirable as capital is in farming, that man cannot be called a good farmer who is obliged to draw funds from

other sources besides the farm he cultivates, for the purpose of defraying the expenses of the farm. If a farmer launches into debt beyond the resources of his farm, and gains a great reputation for being a good farmer by producing at an enormous expense neat cattle, or other stock, or unusually large crops of grain by means of a foreign manure, the world will soon see that such a system of management is not "paying farming;" and that if persisted in it will most surely lead to insolvency and ruin.

22. What, then, is paying farming? We answer, it is that system of management in which our old worn-out farms are renovated from their greatly impoverished condition—the poor land rendered good and productive, and the good land rendered better—paying the cost of cultivation, and the interest on the capital invested; and leaving a profit to the proprietor, all from *the resources of the farm.* Paying farming is based upon the supposition that the buildings and fences of the farm, and the farm *itself,* are all computed at a fair price or prices for *agricultural purposes.* In multitudes of instances farms are bought and sold at prices entirely too high for agricultural purposes, and at such prices the very best system of management in the world must be set down as non-paying farming.

23. Let us suppose, for example, that a farm of one hundred acres is valued at sixty dollars per acre; and is under the best system of management, so that it may be said, with great propriety, "*farming pays*" on that farm. Now suppose the cost of buildings and fences be increased from their present value five thousand dollars, this would increase the value of the farm to such an extent that it is quite doubtful whether farming might be said to pay in *both* cases; notwithstanding the farming *could* be said to be paying when the buildings, fences, and so forth, were valued at a figure not beyond the available resources of the land when under good cultivation. The correct idea is, that a system of management may be a *paying* system, and farmer-like, in every respect, and still be inadequate in its available resources to the large interest on unnecessarily expensive buildings or

on any thing else which may be computed more as an *expense* than a profit to a farmer.

WHY FARMING PAYS NO BETTER.

24. The reasons why farming does not pay better than it appears to in multitudes of instances, are as cogent and plausible as they are numerous. A few of the chiefest of them will be noticed in a brief and summary manner. The first and the *greatest* reason why farming does not pay better is, farmers do not half understand managing the various operations of the farm and cultivating the soil. They are not masters of their business; and, instead of being able to *excel* in most of the branches of farming, they are sadly deficient in the practical understanding of those branches which are so essential to their success. Farming is not only one of the greatest *arts*, but is a great *science*; and he who understands well the proper cultivation of the soil, and the different branches intimately connected with it, is a man of science, whether, in a literary point of view, he knows U from an ox bow or not. Therefore, as multitudes of farmers are almost entirely deficient in a correct understanding of this great art and science, they grope along, as if they were blindfolded, without knowing whether their practices and systems of management are at all correct or decidedly defective.

25. Another good reason why farming pays no better is, farmers do not underdrain their land sufficiently to produce either grain, grass, fruit or vegetables. In most localities, taking the entire country through, the injury done to crops of all kinds by an excess of water in the soil will amount to more, in dollars and cents, than the damage arising from all other sources. Want of proper drainage, then, may be set down as one of the first reasons why farming pays no better than it does. See Chapter on Soils. Numerous instances occur every year, where a field yields sometimes one-fourth, one-third, and even one-half more, the next season after it has been underdrained, than it ever did before in one season, which affords us ocular demonstration that want of drainage is often the greatest reason why farming pays no better.

26. Another cogent reason is, proprietors of farms do not husband their manurial resources sufficiently to keep their soil in a good state of fertility. This practice will involve consuming a large proportion of the coarse grain raised on the farm; thus obtaining the cash value of the grain and other productions in the sales of beef, mutton and pork, and retaining a large proportion of the refuse of the crops for improving the fertility of the soil.

27. Among the many other reasons that might be enumerated why farming pays no better, are a want of a judicious system of rotation of crops, a mixed husbandry, and the general management of all the branches of field and in-door agriculture. All of these reasons are to be considered in close connection with those previously mentioned. But, after all that has been penned, everything will depend on the management of the proprietor. A poor manager is like a broken link in a good chain, which would be worthless, in a certain sense, because one link is broken. So it is with farming. If the general management is defective, although the best systems of agriculture may have been adopted, farming cannot and will not pay. By *general management* is meant executing or carrying out the plans and systems that have been adopted. This will involve doing everything well, and in good time; having a place for everything, and keeping everything in its proper place; as well as *what* to do, and *how* to do it.

WHAT IS NOT SCIENTIFIC AGRICULTURE.

28. Cultivating the soil, as many men do, in such a manner that it is less productive every season, is not scientific agriculture. Deep plowing of wet soils without under draining; endeavoring to raise large crops without applying some fertilizing matter to the soil, to keep it in a good state of fertility; allowing stock of all kinds to become spring poor, during the foddering season; making a great show of *theoretical* and scientific knowledge, while practices are adopted inconsistent with science, and many other things, which sensible people have denominated scientific, are very far from scientific agriculture.

29. When some young city dandy, who has plenty of money, starts up to be a farmer; and, with his varnished and fancifully-stenciled implements of husbandry, with his barrels of ground bone, bags of phosphate and guano, and with his retinue of Tims and Pats, just from the Emerald Isle, none of whom, boss or laborer, knows any more about either theoretical or practical agriculture than they do about the practical part of wax work; they make such droll steerage in everything they attempt to perform, that people laugh in their sleeve and say: "That's scientific agriculture!" Illustrious stupidity! There is not one half as much correct scientific agriculture in all of that parade and counterfeit cultivation of the soil as there is of the science of medicine in a cat's eating catnip to cure the hydrophobia. It is a misnomer to call such manœuvring scientific agriculture. Again: people often see some intelligent, *theoretical* farmer commence agricultural operation; and his knowledge, for the most part, is only *theoretical*. Of course in executing the details of his practice, he as well as those in his employ will work awkwardly and unskilfully. They smile at such management and exclaim: "That's scientific agriculture!" But the wrong word is used in the wrong place. This is nothing but *theoretical* agriculture. There is none of the *scientific* about it.

WHAT IS SCIENTIFIC AGRICULTURE?

30. Scientific agriculture consists neither in theory or practice alone; but in combining the best theory with the most approved practice in farming operations. Scientific agriculture then involves—not knowing how to analyze soils, but such a knowledge of them as will enable a man to adapt the most suitable crops to each particular soil; and also a correct understanding of the most approved manner of performing all the operations connected with raising crops, as well as of keeping the soil in a good state of fertility with the materials that the farm affords. See this thought more fully elucidated in the Chapter on Manures. This last consideration involves a correct understanding of the principles of breeding, rearing, and fattening all kinds of domestic

animals, of saving and applying their manure to the soil, and of cultivating the soil and raising grass or grain. All these considerations, taken in harmonious combination, constitute the sum total of scientific agriculture. It matters not if a farmer's library consists of only the Holy Bible and the Babes in the Woods, if he has a correct understanding of keeping his soil in a good state of fertility with only the materials which it affords; and if he raises good crops, and secures them well, that farmer's practices may be denominated *scientific agriculture.* Correct theory and correct practice, in the operations of a farm, make up the *scientific.* But, theory or practice alone will not do it.

31. The *Genesee Farmer* says: "It must be confessed that a man may have a good theoretical knowledge of agriculture, and yet make a poor farmer. Order, system, personal attention to details, with steady, persistent industry, will enable a farmer to succeed, without the slightest acquaintance with science; while, on the other hand, the most thorough scientific education will be of little use to the man who has not these qualities. If a man, who has had the advantage of a scientific agricultural education, turns farmer, he will be pretty sure to make mistakes which will subject him to the ridicule of his neighbors. He may be the most quiet of men—be entirely occupied with his own affairs—interfering in no way with those of others. But no matter. Those of his neighbors who have less to think about will be sure to talk over all that he does, and their comment will not generally be of a complimentary kind. Agriculture is slow work. A farm cannot be brought into order and a high state of cultivation in a year. It is the labor of a life."

32. The scientific man who thinks that he can take a farm and raise large crops by the use of a few chemical manures, is doomed to disappointment. He will be very apt to neglect those little details of farm economy which are absolutely essential to success. While he is thinking of acids, alkalies, of nitrogen and phosphates, his cattle will knock down a fence and eat up his crops. While he is studying Liebig, his men will be taking a *siesta* in the hayfield. Careless hands will soon break his im-

proved implements. He may think to economize food by cooking it; but without constant surveillance, his men will waste more in a day than he can save in a week. They will take pleasure in thwarting all his pet plans; and will harass and perplex him in every conceivable way. The end is disappointment and disgust.

33. But it is only the mere dabbler in science that expects to revolutionize agriculture. The true scientific man has moderate expectations. He does not know, and never expects to know, how to transmute iron into gold, or to raise a hundred bushels of wheat per acre, as easily as we now raise ten. If any discovery he can make, if any modification of present practices will increase the productiveness of the soil five bushels per acre, he knows that he would be one of the greatest benefactors of his race. Theory can never resist facts that have once been fairly established. *Facts* are the leaves of science. *Theory* alone is not scientific. And yet it is too commonly conceded, that if a man theorizes much he is a very scientific man. *Moore's Rural New Yorker* says: "The farmer who is governed in his system of farm management by the most extended experience and practical observation of the relation of facts to each other, is the most *scientific farmer*, no matter whether he ever read a scientific book or not. The breeder of sheep, or cattle, who is governed in his breeding by laws which his experience has brought out for him, is really a *scientific breeder*, no matter whether his practice conflicts with the rules of theoretical writers or not."

A SUCCESSFUL FARMER MUST BE A CONSUMER.

34. Consuming the productions of the soil on the farm where they were raised, is a practice which lies at the foundation of scientific and successful agriculture. Indeed, it is the only correct system of farm management which is worthy of universal recommendation. It is true there are numerous instances of good agriculture, where everything that a soil produces is transported to some other part of the country. But even in such instances, a system, which is *equivalent* to a consuming system, is adopted.

Near many of our populous cities every article that the soil has produced during the season is removed many miles distant, and consumed, where no portion of it is ever returned to the soil. But in such instances the proprietors are careful to enrich their soils with fertilizing materials such as ground bone, poudrette, guano, gypsum, lime, or stable manure.

35. But the large proportion of the farmers of our country are too remote from market to transport a very considerable portion of the products of their soil to some place where it may be profitably consumed. For this reason, if a farmer would keep his soil in a good state of fertility from year to year, so that it will be quite as productive—or more so—when he has ceased to be proprietor of it, the only correct and feasible system of management, which will enable him to accomplish such an object, will be to consume everything that his farm produces, so far as may be practicable, at home, and return the refuse and waste material to the soil. If a man is as intelligent as he should be, these suggestions will enable him to adopt some satisfactory system of management, which will be quite as profitable for him in dollars and cents, and infinitely better for his soil. Read the Introduction to Vol. I.

36. The grand and leading idea on this subject is to use up the products of the farm in such a manner as will render the same profits to the proprietor that he would receive were he to sell them when those products were in a different condition. We want to sell the products, and at the same time make such a disposition of them that the soil will not be impoverished by removing crops from it. We want to keep our cake and eat it too, in a certain sense. For example: if a farmer raises one hundred bushels of Indian corn, his aim should be to use it up in such manner that his soil will not be impoverished. The same is true of his other crops of cereal grain and grass. By feeding out one hundred bushels of Indian corn in the most economical manner, and to the best kind of swine, cattle, or sheep, and by saving all their manure and applying it to the soil where the corn grew, and by cultivating that soil in a most thorough manner, its fertility

may be improved, and rendered more productive from year to year.

PURCHASING A FARM—ARE YOU A PRACTICAL FARMER?

37. If you are not, whether you possess an abundance of capital to purchase a farm with, or not, my first advice is that you spend a year or two on some farm, and gain a correct knowledge of the business before you engage in it. There is something else to do on a farm than to walk around the fields with gloves on, and a staff in hand, and see the crops grow. There is a vast amount of hard labor to be done. And if a man is not able to perform much manual labor, he had better not be a farmer. If a man invests his money in mortgages or notes, he will usually receive his income without much thought or anxiety. But when it is invested in land that must be cultivated, the proprietor must be a good farmer, in order to succeed well, in obtaining an annual income which will be a fair equivalent for the use of capital invested and for the service performed. And, in addition to this, he must keep his property from depreciating in value. Otherwise, he will soon "come out of the little end of the horn," as we Americans say of a failure in any enterprise. Thousands of men have fancied that farming is a delightful occupation; and have engaged in it without knowing any more about its details, and the successes and reverses attending it, as a livelihood, than a common farmer knows about navigating the ocean. Consequently, they soon failed to meet with success, simply because they did not understand the business.

38. If you are a practical farmer, and if you like laborious and active employment, and can say *aye* to the description of a farmer in Vol. I., page 14; and if you have come, deliberately, to the conclusion to like agriculture—hard or easy, wet or dry, cold or hot, great pains with small gains, and *vice versa*—then you are fully prepared to put on your toga and India rubber boots, and work your passage to earthly bliss through swamps and bogs, hedges and ditches, as well as among stones, stumps and heaps of compost. And if you always keep cool and never fret, glorious success and substantial happiness will eventually

encircle you, like a halo of agricultural glory. The next important consideration, when about to purchase a farm, will be

SUFFICIENT CAPITAL.

39. There is no other occupation in which capital is more important than in agriculture. If a farmer has a limited capital, he will often find farming to be disagreeable and up-hill business. He cannot expect to succeed without a fair amount of capital, any more than a banker or a tradesman, who employs but little in his business. Some cash will be essential, in addition to good stock and a good soil. What I mean to have understood is, that a farmer should have capital enough on hand to defray his expenses, and a little more. There will be some improvements to be carried out almost every season. Laborers must be paid as they go ; the family must be supported ; and a man frequently meets with excellent opportunities to purchase stock for his farm at a great bargain. For all such things, a few hundred dollars of loose capital will be requisite, in order to good success. A farmer's *main* capital will be invested in his farm, implements of husbandry, and in his live stock. But if he has no loose capital besides these, he will too often find himself in a position like that of a stranger in a strange country whose property and cash are many hundreds of miles distant from him. A speculator never thinks of obtaining his livelihood by buying and selling without first obtaining a suitable amount of capital with which to transact his business. A farmer, in order to succeed, needs capital just as much as a speculator.

PAY DEBTS AS YOU GO.

40. At some seasons of the year, cash appears to be, necessarily, paid out much faster than it comes in. When this is the case, it will be infinitely better for a man—better for his credit—better for his integrity—better for his creditors—better for his family—and better in every other point of view—to hire fifty or a hundred dollars for a few months, for the purpose of paying small bills—little debts—as he goes. These little five and ten cent

bills at the blacksmith's shop; these little bills at groceries, which cannot be avoided conveniently, had better be paid at the time they are contracted, even though it were necessary to pay interest for a few months on the money to do it with. It is not a good practice for a farmer to allow every stroke of a blacksmith's hammer to be entered on his book. But few men will keep a book account for nothing from year to year. And if those with whom we are accustomed to deal always understand that a man deals *in cash, in little debts as well as in large ones, dealers will allow* that man advantages in prices which a slack paymaster can never avail himself of.

41. When I see a man go to a blacksmith's shop to get a tenpenny job done; or to a grocery to trade a few dimes, who always says "you may charge this bill;" and who calculates to pay when his creditors feel willing to take their pay in catskins, or in a quarter of poor beef, or a leg of some imbecile old buck that is too old for mutton, I always think, My dear sir, that system of management renders your business more than ten fold harder, and more expensive and perplexing, than it would be were you to pay your little debts as you go. But fools and silly people can never be made to believe it.

PAY AS YOU GO.

42. Let me reiterate it in the ears of every young man, whose aspirations ever prompt him to be anybody in the world, to pay your *little* debts as you go. Little things make the man. Little traits of character enable us to decide with great certainty what are a man's cherished affections; and in little things we discover manifestations of his ruling passion. The world will measure a man by his attention to little things—by his promptness in paying his *little debts*. The world will weigh a man's character—not by what they *hear* about him—but by what they *see* in him. The world will speak of a man as they find him, with reference to his manner of doing business. Among the undesirable and repugnant traits of character, this one, of allowing little debts to go unpaid, discloses a trait more ignoble than we can discover

in him whose habitual weakness is to debase himself, by drinking intoxicating beverages to such an extent as to disgrace and ruin his character.

43. Again, let me repeat and reiterate for the last time, "*pay as you go.*" It will make a man a better citizen to pay all his little debts as he goes. He will esteem *himself* more highly for it; and that trait of character will secure for him a degree of respectability, in every sphere where he may move, that he never can experience if he adopts the loose, dishonest, unbusiness-like, slip-shod kind of a way of paying little debts only when they *must* be paid. Rest assured, my young reader, that your character as a successful cultivator of the soil will depend, in a far greater degree than you may imagine, on your readiness, your promptness and punctuality, in paying your *little* debts.

44. Pay as you go, young man. Pay your *little* debts. Never let it be said of you by any one: "That man owes me a dime, or a quarter of a dollar; and I would rather lose it than to ask him for it." Pay your day laborers every day, or every week at longest. They will work much better for it. Pay all little debts at mechanics' shops as soon as the work is done. They will deal cheaper on account of it. Let it be interwoven with the cardinal virtues of morality and religion, to pay every incidental indebtedness with promptness, with cheerfulness, and without murmuring and grumbling. If a man is not faithful in these *little* transactions, we can cherish no hope that he will pay his indebtedness to the soil which he cultivates, by returning to it, in fertilizing material of some kind, an equivalent for the crops which he has removed.

45. Pay as you go. For the world is full of unprincipled men, sailing under the agricultural flag of the United States of America, who run a dishonorable career, and lead a wretched life, simply because they never *calculate* to pay as they go. They are always ready and anxious to borrow a dime or a dollar, whether they have immediate use for it or not. And they never make calculations to pay it. Mechanics will always tax them a higher price for any article that they may purchase, than

they do a man who pays cash; because they never make calculation to pay. Neighbors and friends are never willing to accommodate them; because they never make calculations to pay. Every paper or periodical that they subscribe for, costs one third or one fourth more than it does him who pays as he goes; because they do not make calculations to pay when it is due. The agriculture of our country is being ruined by the unfarmerlike management of such men. They contracted the loose habit of not paying their little debts as they went along; and thus they fell into the slip-shod practice of not paying the little indebtedness to their soil.

RUNNING INTO DEBT FOR LAND.

46. We have often read instructions to young farmers, to "avoid running into debt, as one would avoid a deadly pestilence or famine." But, for *honest* men, this is a species of old fogyism. For dishonest men—those who will borrow, or purchase all they have an opportunity to purchase—who never make any calculations to pay a debt, such advice would be applicable. It never is any detriment to an *honest* man to contract debts for a good farm to a limited extent. Indeed, it almost always has a tendency to make him a better citizen than he otherwise would be, if he owed no man anything but *love*, and had a pocketful of money besides. If an honest, energetic farmer should run into debt for a portion of his land, and by good economy, and well-directed labor, can manage so as to pay the interest annually on his indebtedness, and to reduce the principal a little, he has a laudable object to prompt him to industry and frugality. This has been the making of thousands of our best farmers. And my advice would be, don't fear to run into debt for a portion of a good farm, providing you do not pay more per acre for it than it is really worth for agricultural purposes; and, providing you can discover some sure way to keep it good, to pay the interest, and a small proportion of the indebtedness every year. The only correct way of determining this point, satisfactorily, will be to compute the interest on the capital invested; the probable ex-

pense of cultivation; the expense of manuring, in order to keep it in a good state of fertility; and to compare the amount with the aggregate value of the produce for one year. The difference will exhibit a sum that will enable the proprietor to decide whether he will be able, in the course of a few years, to pay for his farm; or whether he will be obliged to labor hard all his days without accumulating enough to defray the expense of a respectable burial.

THE PRICE OF LAND TOO HIGH FOR AGRICULTURAL PURPOSES.

47. A large proportion of the improved land of our country is held at a price quite too high to pay the legal interest, and the expense of cultivation, when it is appropriated to agricultural purposes. For this reason, young farmers, in particular, should be cautious about running into debt, for any considerable portion of a farm, with the expectation of paying off the indebtedness from the sales of the products of that farm. If a man has the money on hand to pay for a situation; and is not particular whether his soil will pay the interest and expense of cultivation, from year to year, this advice will be of no practical utility. Our aim is to aid those who need assistance; and to counsel those who are seeking for advice, that will aid them at a time when a little help will be of great value to them. It is an easy thing for one to make an estimate of the probable expense of cultivating a hundred acres of land for a year, and of the probable income from the sale of the products of the soil; and then deduct the amount of taxes, and repairs, and improvements; and to strike a balance, as an equivalent for his services. But he must be a good practical man—well acquainted with all the details in every branch of his business—before he can form a correct estimate on every point.

48. In making this estimate, however, it will be necessary to be able to decide, correctly, as to the amount of cash products of a farm for several successive seasons. For example: if land be valued at one hundred dollars per acre, and will produce three tons of hay per acre, valued at fifteen dollars per ton,

after it has been delivered at the market, then there will be the interest on that one hundred dollars annually; the tax on the land; the cost for fertilizers to keep the soil good, which shall be equivalent to the crop of hay removed; and all the other expenses attending the hay crop, not omitting a portion of the expense of tools and implements with which to perform the labor. And it must be kept in mind, also, that a soil must be in an excellent state of fertility to yield three tons of good hay, by actual weight, per acre. And that degree of fertility must be maintained; and the expense of maintaining it will often be much greater than those are accustomed to suppose, who are not familiar with all the details incident to the labors of the field, the stable, and stock barns.

49. Again, we will suppose that the soil is to be grazed, instead of plowed. Now then, here will be the interest on the land, the taxes; the cost of fertilizing material to keep the soil good, and the expense of making butter or cheese; or, taking care of fattening bullocks; or the expense incurred in growing wool, and mutton. As all the items above named are valued at different *prices in different localities, it will be necessary to compute the* price of each as it corresponds with its respective locality. Another important consideration will be the

DIFFERENCE, IN VALUE, BETWEEN GOOD LAND AND POOR.

50. When a man contemplates purchasing a farm, he is apt to think more of the *location* and *view* than of almost anything else. True, it is convenient to be near the post office, and the R. R. depot, and the steam boat landing, and places of public business. But every one cannot be located within a few minutes' walk or drive of such public places. And the nearer one locates to such places, the more expensive, per acre, the land will be; and, in many instances, the poorer and less productive it is. But the price per acre almost always increases as one approaches such places. In the selection of a farm, the soil should be thoroughly examined, to ascertain whether it is naturally barren or fertile. If it is naturally poor, thin and unproductive, and somewhat wet,

it must be purchased at a low figure indeed, or the proprietor will have a task before him, and a debt on his hands that will "bring down his gray hairs with sorrow to the grave," before he will be able to make farming pay.

51. When a man pays sixty, seventy, eighty, or more dollars per acre, for land that is not worth, for agricultural purposes, more than fifteen or twenty dollars, and which will not pay the interest of six per cent., at twenty dollars per acre, I want to tell him, "he has paid too dear for his whistle"; and the most profitable shift he can make will be to dispose of his poor land, even at ten dollars per acre, if he can get no more If a man purchase poor, unproductive land, he should be certain to get it at a low price. It will be infinitely better to pay one hundred, or even two hundred dollars per acre, for land that is naturally productive, and in a good state of fertility, and that does not need an expenditure of more than half its value per acre, to put it in even an ordinary state of fertility, than to purchase a poor soil at a low price.

52. Let me illustrate this subject in a practical point of view. Belonging to the farm that I once owned, there were certain fields which were, to all natural appearances, exactly like the fields of my neighbor, just over the fence. He valued his land at as many dollars, per acre, as I did my own; and the estimated valuation of both farms by the Town Assessors was about the same number of dollars per acre. He raised oats; and I also raised oats, one season, on a field close by the side of his. He told me that his field averaged, per acre, twenty three bushels of clear oats. My field averaged seventy bushels of much nicer oats than his. The yield of Indian corn on his field was about half as much as on mine. The same field of mine yielded about forty two bushels of buckwheat per acre; while his yielded, he said, about ten or twelve bushels per acre. And the amount of wheat on my field was more than twice as much, per acre, as on his. And when we come to pasture, one acre of my pasture sustained more stock than three acres of his.

53. But people would say almost uniformly, "your farm is

worth much more per acre, because your *buildings* are so much better than his." The much larger quantity of produce that my fields yielded per acre more than his was hardly thought of. Now, if my soil could produce more than twice as much per acre, was it not worth at least twice as many dollars per acre as his? Most certainly so. Consider, for a moment, how much must be expended in procuring fertilizers for a long succession of years, before it could be brought up to a state of equal fertility and productiveness with my fields. While his fields would produce only about enough to pay the expense of cultivation, from year to year, my fields would yield enough to purchase themselves more than twice over, in addition to paying the expense of cultivation, and of keeping the soil in a good state of fertility. There may be fields, on a great many farms, all over our country, that are bought and sold, every few years, which have produced grain enough, during those few years, not only to pay for their own cost per acre, but to pay for other portions of the same farm which were too poor to yield enough to pay for themselves. That will be the kind of land to purchase. But the grand difficulty is, a young farmer does not know positively when he has found such a farm.

POOR FARMS OF NEW ENGLAND.

54. I have seen thousands of acres in New England, and in some other States also, that would not yield fifteen hundred pounds of hay per acre, and grain in the same ratio, which had been bought and sold, and sold again and again, at cash prices per acre, which could not be paid from the sales of all the products that could be raised on it, for more than thirty years to come. Herein lies the great error; certain fields on certain farms will yield enormous crops of grass, grain or roots, enough to defray *all* the expenses of cultivation, the interest and the taxes. There is no danger of paying too much for such land per acre. But there is great danger of estimating the cash value of poor land too highly; and no error is more common—often among intelligent farmers too—than to estimate the productiveness of such poor soils by what they are capable of being rendered after

expending half their cash value in improvements on them rather than making an estimate of their present value, while in their unproductive condition. It will be better every way to pay a large price for good land, than to purchase poor land at even a figure correspondingly low.

WHEN AND HOW TO EXAMINE A FARM.

55. When a man goes into the forest for the purpose of purchasing timber that has been cut down, does he select a time when it is all covered with a deep snow? Never. But in most instances, when men purchase farms, they examine them when there is little else to be seen besides huge snow banks, trees and fences. They travel around and examine the boundaries, and the fences and buildings; and they inquire what kind of produce has been raised; and how much the yield was per acre. And after they have finished a satisfactory examination, they know just as much about that farm as they did before they made an examination and usually not any more. Men do not intend to lie right out; but I know—yes, that's the correct word—I know that most men, when they are interrogated as to how many bushels of a certain kind of grain they have raised per acre, will answer, "Well, about so many. It was a splendid crop! Why, you never saw such heavy grain or grass!" I have heard men affirm that they had sixty bushels of barley per acre, of splendid grain, and forty bushels of wheat, which would all make excellent seed!" when they knew, and I knew, that there was not an acre in their whole county that yielded that amount. Here is the point on which young farmers will be deceived, concerning the productiveness of a soil. A man wants to see the soil; see it plowed; see the crops growing on it; see them at harvest time; and to examine the grain after it comes to maturity. What can one learn of the productiveness of a soil when it is all covered up with a deep snow? His judgment will tell him that there is a soil beneath the snow; but it may be so barren that it would not yield white beans. There is a vast deal of such land in our country. And to the proprietor, it is [illegible]

self-righteousness—the more one possesses of it, the worse it always will be for him.

56. Were I about to purchase a farm, I would make extensive inquiry concerning its productiveness in years past; and endeavor to learn what had been the system of management on it during previous years. Then, I would visit it—not when it was covered with a deep snow—but in the spring, both when it was very wet, everywhere, as well as when dry. I would see the soil plowed up and undergoing *pulverization*. At harvest time I would visit it again, before the crops were gathered; and go among the standing grain or grass. It is an easy matter to be deceived, when looking at a field of grain, unless one goes among it. A crop will appear, many times, to be a heavy one, as it is viewed from simply passing by it. But, when a man goes among the standing grain of a field, he can see what it produces. And what he can see with his own eyes, and handle with his own hands, he will need no further information about.

57. Here is one other important suggestion. In case a field has not been plowed for many years, if it be well sodded over with grass, the soil will be good. But, if the grass has disappeared, and a field *has many bare spots, where there is no vegetation at all*, I would travel on. If blackberry bushes, Canada thistles, milk weed, bull thistles, and other similar noxious weeds were flourishing luxuriantly, and vieing with each other for the ascendancy, I would select that soil as a good one. The larger those noxious weeds would grow, the more productive the soil will prove to be. This sign will never deceive us. If those noxious plants were small and slender, where there was nothing to hinder their growth, I would defer purchasing, till I could find a soil that would produce Canada thistles so large, that if a swath were moved through them, it would be difficult to induce animals to go among those that are standing. At the present writing, a friend of mine had just returned, with his family, from the highly extolled Vine Land, after having sacrificed half his estate to remove them, and the other half of it to return. His wife, who was a good farmer, refused to unpack their goods when she saw the face of the country; because she said there was

not herbage enough to keep a cow. And if a cow could'nt live they surely must starve.

THE WAY TO COMMENCE FARMING.

"Here, then our task begins. Tis pleasant toil
To tend the flocks and herds, and break the soil."

58. As soon as a man becomes proprietor of a farm, with a design to pursue the cultivation of the soil, for his livelihood, if he is an intelligent and thoughtful man, his first inquiry will be, what system of farm-management can I adopt which will enable me to distinguish myself as a successful agriculturist; or which will return to me a fair equivalent for the capital invested, as well as a satisfactory remuneration for my labor; and at the same time leave my farm in a condition quite as productive—or even more so—than it was, when I commenced farming operations. No problem in geometry was ever more difficult to solve. There is the farm; and here are the forces to work it. And so we may say in another respect: there is the piano, and here is the music to be played. But what are these without musical talent and musical skill? And what is a farm, and tools, and implements, and forces without knowledge and skill to manage them? The first thing will be to plot the farm properly. The details for doing this will be found in Volume I. p. 29. The next step to be taken will be to adapt the crops to the quality of the soil. Read the remarks on this subject in the Chapter on Soils. Then, if any portion of it be wet, calculations should be made to drain it as soon as may be practicable. Read Chapter on Draining in Vol. I. The next consideration will be to adopt

A SYSTEM OF MIXED HUSBANDRY.

"One cow, and a pig, and a lamb and a calf,
And plenty of corn, good husbandry hath."

EDWARDS.

59. It is universally acknowledged, I believe, by the most successful farmers, not only in the Old World but in America, that a *mixed husbandry*—rearing and feeding neat cattle, sheep

and swine, in connection with raising grain—lies at the foundation of successful and progressive agriculture. Still it is not denied that there is much good agriculture in the world which pays well, and which might be called progressive farming, where not a hoof is kept from one year to the other. But in order that agriculture may be paying, and the same time a self-sustaining system, the only reliable way is, to keep more or less stock, and consume a large proportion of the coarse grain which is raised on the farm. If a farmer has an abundance of surplus capital with which he can purchase guano, ground bone, poudrette, or other fertilizers, he may keep his soil good, and raise large crops of grain or grass without keeping stock of any kind. But this would not be such a system of farm management as I would endorse or recommend to those who are about to commence farm operations. The great idea in mixed husbandry is, to commence with a limited capital, and to adopt such a system of management as will return capital enough to defray the expense of cultivation and pay for the improvements on the farm, and leave a profit towards paying for the land, and, at the same time, not impoverish the soil at all; but, on the contrary, improve its fertility from year to year.

60. What I desire to have understood by a *mixed* husbandry is, a system of farm management in which raising grain constitutes only a portion of a farmer's employment; while raising stock of some kind is a chief part of his business. In other words, raising stock and growing grain on the same farm possesses decided advantages over that system of husbandry in which nothing but grain is grown or stock reared. A system of mixed husbandry involves all the good practices to which we have made allusions in this chapter. And it may not be amiss to allude to some of the immediate advantages arising from such a system. I have my mind on a man who owned only a small plot of land, who raised an excellent crop of Indian corn every season for twenty-two successive years on one field. No other crop was ever grown on that field during that period. And the twenty-second crop yielded a larger number of bushels of good grain than the first, or any other crop during that period of time.

He always kept two good cows, and fattened two excellent hogs; and most of the manure that they made was applied to the soil where his corn grew.

61. This instance affords us an example of mixed husbandry on a limited scale. But it was by no means a perfect, or even a commendable system of agriculture. If he had adopted, in connection with this system, a three or four years rotation-of-crops system, the Indian corn which was raised the twenty-second year would have been heavier, and the system a most complete one. Let us notice wherein it could have been improved. The soil and locality were well adapted to raising wheat, barley, oats, potatoes, beans, or grass. Now, as Indian corn requires certain elements of the soil different from wheat, oats or barley, by growing a crop of Indian corn every season on that same soil, there was an extraordinary demand for those fertilizers only which Indian corn required. There was a great abundance of material in the soil that would have produced oats, barley, and wheat, which the roots of Indian corn would not take up. Here, then, we may perceive, and can appreciate the excellence and importance of adopting

A ROTATION SYSTEM IN CONNECTION WITH MIXED HUSBANDRY.

62. Had the man alluded to in the preceding paragraph raised wheat, barley and oats, in connection with his Indian corn, there would have been opportunity for the corn-producing material in his soil to accumulate, during three or four seasons, even while the soil produced a good crop of other grain. Then, after four years of good cultivation, the corn-producing material would have been so abundant, that instead of fifty bushels of grain of an ordinary quality, twice that amount would have been produced with the same cultivation. If a farmer desires to raise bountiful crops of any kind of grain or grass, he cannot expect to be able to do it on a soil that has been exhausted of most of those substances which are required to produce that kind of grain. But by raising stock in connection with growing grain; by feeding out a large portion of coarse grain to animals; by husbanding all the resources for saving and preparing fertilizing mate-

rials for the soil; and by adopting a judicious system of rotation crops which are adapted to the soil and to the locality, the grain-producing material which is especially adapted to promoting the growth of each kind of grain will have time to accumulate in the soil, so that whenever a given crop of grain or grass is to be grown, there will be such an abundance of it, that not only the stalks, but the grain will be large in quantity, and superior in quality.

63. In case a farmer keeps sheep in connection with grain raising, he will want one or more cows to furnish milk and butter. Then, lard will be very essential for culinary purposes, to say nothing of the value of pork for food. Then, a span or two of good horses will be indispensable; and if a farm is large, it will be necessary to keep two spans of horses or a yoke of good oxen. See Horses *vs.* Oxen for a Team. All these animals are absolutely necessary, even on a grain farm. Therefore where such animals are kept, we have all the elements of a good system of mixed husbandry to begin with. And now, if everything be arranged harmoniously in connection with a judicious system of rotation of crops—providing all the manure is made and saved and properly applied that can be; and if the soil is thoroughly drained where it is too wet, and properly cultivated, and every operation performed in good time and in a farmer-like manner—we may rest assured that success will as certainly attend the efforts of the husbandman, as we are sure that the promise of "seed time and harvest shall not cease." Gen. viii. 22.

RAISING AND FATTENING CATTLE AND SHEEP.

64. In order to come fully up to the standard and practice of a thrifty and successful cultivator of the soil, every farmer should calculate to keep some kind of stock—neat cattle or sheep—to consume and to work into manure the corn stalks, straw and coarse grain. It is, and always has been, and always will be, "penny-wise and pound-foolish" policy to keep poor animals, or to keep animals poor. It has ever been a mystery that I could not unravel, why multitudes of farmers could be so regardless

of their own interests as to allow their animals to come into the barnyard in a thrifty, fleshy condition in late autumn, and to return to the pasture in the succeeding spring greatly emaciated, like the lean kine of Pharaoh. Gen. xli. 3. It is the worst policy on the whole farm to allow animals of any kind to grow poor. A farmer should not attempt to keep one more animal than he can keep in a growing thrifty condition. It will be far better to keep one good cow, or calf, or bullock, or sheep, and allow it to have all that it can eat, and a little to spare, than to keep so many that they must gnaw all day before they will be able to fill themselves. And besides, it is bad policy to have grass gnawed into the earth at any season of the year; and especially in late autumn and early in the spring. Most farmers try to keep too many half-starved animals. But it is a practice which deserves the severest condemnation. One good well-fed cow will yield more milk, and butter, or cheese than two half-fed, poverty-stricken cows. It will be far better for the farm, and better every way, to keep cows so well, that they will yield milk enough to produce from two to three hundred pounds of butter each in a year, than it will be to keep so many that not more than 100 lbs. can be realized from each cow. And it will be more profitable to keep but one hog, or one sheep, or fat steer, than to allow two animals to be fattened on an allowance that one would consume.

65. I have always acted on the policy that it is better to *save* a pound of fat or flesh than to attempt to produce it; and it is better for a farm—better for a man's pocket—better for animals, and infinitely more satisfactory in every point of view—to protect animals from the inclement cold and pelting storms than it is to compel them to protect themselves. Every cold and stormy night that an animal is compelled to lie out unprotected, costs his owner not less than the price of a pound of the best flesh or of tallow. This assertion cannot be refuted. And many times it will cost him as much in cash material as he would be obliged to pay for his own lodging for a night at a good country hotel. No farmer should think of attempting to keep any animals in a

climate like ours without suitable sheds or stables for protection, during autumnal and winter storms. One severe storm in Nov. will use up more of an animal's fat and flesh, if it is not protected, than it will gain in seven days. Animals are composed of flesh and blood; and they, like us, feel the cold changes in autumn as well as we do; and experience the same inconvenience, in a measure, that we would if unprotected.

BEGINNING WRONG AND ENDING RIGHT.

66. By following in the wrong path, one will most certainly arrive at a wrong place. This holds good in morals and religion, as well as in agriculture. But in case a farmer begins wrong, if he can only manage *to end right*—no, it will not be as well *in agriculture* as it would be if he began right. When I commenced farming operations, most of my farm had been much impover ished by a long succession of exhausting crops which had been carried off; and but little, if anything, returned to the soil. Without any cash ahead to invest in any improvements, I followed in the train of most farmers for two years, when I became convinced that I must commence a renovating system, or emigrate. I had lots of straw and corn stalks and hay; but before grass appeared in the spring, I was compelled to look up a little hay, which always disappeared like the morning dew before a summer sun. Disheartened at such a system of management, I resolved to turn square about, and make a better use of my knowledge in economizing my coarse fodder. In the first place, a railway horse power was purchased, with which I did my own thrashing. A few hundred bundles of grain were thrashed and cut with a little hay and cornstalks; and every animal, from a calf to a team, received a regular allowance of cut feed, with never less than one quart of good meal each per day, or twice a day, unless they had a good supply of hay. But they always received it not less than once a day. After the first lot of feed was consumed, another lot was prepared, and fed in the same manner. I never waited in the fall for animals to commence to grow poor before they were fed with a little meal. Good sheds, and stalls to feed in, were

immediately prepared, not only for protecting stock, but for sheltering the manure. I never retired to rest until I knew that every animal had enough to eat and to drink, and a good comfortable place to lie down, where it could enjoy rumination and quiet rest.

67. In autumn, I practised purchasing a few good steers; and kept them well all winter; and in the spring increased their feed of meal, and let them have grass a few weeks—not omitting their meal—when they would command a ready price, that would make my neighbors, who practised the old system of feeding, exclaim, "*What a thumping price you got for your steers!*" I well remember that the first lot of steers I fed all winter, stalling them in the night, returned me more than one dollar per bushel for the meal which they consumed, and a fair price for their hay, and left a lot of most excellent manure. The market value of such meal was less than fifty cents per bushel. My animals were also kept in a close yard, so that none of their manure was lost.

FATTENING SWINE.

68. Although a separate chapter will be appropriated to rearing and fattening swine, in the Chapter on Raising Stock, still I consider it proper in this place to pen a few general remarks on that important branch of agriculture. Many farmers fail to allow this branch of mixed husbandry to occupy very much of a place in their farm management, because they cannot make it pay. And the true reason why they fail to make it pay is, they do not manage right with their swine. In the first place, let a farmer prepare a good piggery, where he can keep swine always confined, unless it is desirable to allow them to run in the orchard. They should have the benefit of a small yard also, close to the piggery.

69. Now procure a good sow of some excellent breed; and manage so as to have a litter of pigs early in the season; and feed the sow well, and keep them growing. If a pig is ever allowed to be stunted, it will require a long time and much feed to get him again in a thrifty condition. As soon as they begin to feed well at the

trough, if a man has a few cows, the pigs may be weaned. There is nothing equal to milk to give pigs a start. Let their meal be equal quantities of oats, Indian corn, and wheat. Never feed whole grain, except new peas. Oatmeal and wheat-flour will develope the frame and muscles far better than Indian corn meal. Always scald the meal for them. Scalded meal will fatten them full one-third more than raw meal. Mingle the milk of the dairy with the scalded meal. Let the pigs have some grass also. Red clover mowed for them will be excellent. Keep them growing every day. Most farmers simply keep their pigs on dish water and grass, and a little whole grain until autumn; and then push them in fattening. I always managed with my swine so as to keep them growing all summer and all the fall, until they were ready to kill.

70. I used to raise a crop of peas for them. And as soon as they were ripe, commenced feeding on peas in connection with the kind of feed just mentioned. When the peas became dry and hard, they were ground with Indian corn, and the meal was scalded. Regularity in feeding swine, and feeding just as much as they will consume at every meal, three times a day, I always found to be one of the most important considerations in their management. Without this, no man can expect to find it profitable to make pork. I used to feed some boiled potatoes, pumpkins, and apples, mingled with the milk. But I never fed whole grain ; and seldom fed any meal that had not been scalded. And another source of great profit I always found to be in saving their manure and applying it to the soil. These few thoughts will enable young farmers to begin right. The details connected with each subject alluded to under this head will be found in the Chapter on Swine.

PASTURING CATTLE AND SHEEP TOGETHER.

71. Sheep will thrive far better when confined in the same field with neat cattle than the cattle will. And neat cattle—whether they be milk cows, young bullocks, yearlings or calves—will thrive much better when no sheep are allowed to graze in

their pastures, even if there always appears to be an abundant supply of grass. Sheep, usually, nip the young and tender grass much closer than neat cattle. Consequently, when sheep and neat cattle are required to graze in the same field, the sheep will subsist almost entirely on the youngest and tenderest grass in the field; while cattle must take up with a second quality of grass, which the sheep have run over, and from which they have selected the tenderest and best.

72. It is not a commendable system of farm management to keep sheep, horses and neat cattle all in one pasture. Horses and neat cattle will thrive equally well together in the same pasture; but it is not good policy to let sheep have an equal chance in a good pasture with neat cattle and horses. For this reason, a farmer will find it to be a better system of management to keep nothing but sheep; or nothing but neat cattle and horses in the same pastures, and at the same time. If a farmer desire to keep both sheep and neat cattle, the cattle should precede the sheep in every pasture some three or four days. By this arrangement the cattle will be enabled to have an equal advantage with the sheep in grazing the young and fresh grass.

WHAT KIND OF STOCK TO KEEP.

73. The kind of soil that a man cultivates, in connection with the crops he raises, should determine, in a great degree, what kind of stock he should keep on his farm. There is as much science and good philosophy in adapting the right kind of *stock* to the soil, as there is in adapting the right kind of *crops* to the soil. This is a consideration that is seldom thought of by farmers as a class; but when a farmer is about to commence stocking his farm, this is a subject that is intimately connected with his success and profits.

74. Let us particularize on this point. We will suppose, for example, that the soil of a man's farm is a fertile and productive one, and well adapted to raising heavy crops of all kinds of cereal grain. If it will produce abundant crops of wheat, barley, oats,

and Indian corn, we have the best assurance that it will yield heavy crops of the best kind of grass. Therefore we may conclude that the soil will support thoroughbred animals of the largest size, whether they be neat cattle or sheep. If neat cattle be selected to stock such a farm with, perhaps those that have a large infusion of the Durham blood will be found quite as profitable, and doubtless more so, than any other breed that can be selected. Rich soils will produce heavy burdens of grass; and heavy crops of grass will surely make large and profitable cattle.

75. If a farmer prefer to raise sheep instead of neat cattle, then it will be the wisest policy to select such breeds as will yield the greatest profit, both for wool and mutton. Enough can be written on this subject to make one or more long chapters, and the details of managing sheep would occupy more space than the limits of this work will afford. If a soil be rather thin, and somewhat hilly, with barren and unproductive ridges, knolls, low wet swales, and not at all adapted to the production of wheat, and will yield only small crops of oats, Indian corn, flax, and consequently a scanty herbage for animals, then it will be policy to select a different breed of cattle which have small frames and small bones, and which will make plump and handsome animals for beef. In the line of neat cattle, there is no better for such farms than the Devons, except it be for dairy purposes. The Devons will thrive well on the best of soil; and on soils of an inferior character they will succeed much better than neat cattle of a larger breed, like those, for example, that resemble the Durhams, that are nearly or quite thoroughbred. Then, when the selection is made with reference to sheep, in most instances full-blooded South Down, or a cross between the Spanish or American Merino and the South Down, will usually be found quite as successful and profitable, both for wool and mutton, as any other breed. And they will be much more profitable, in most instances, than the large-framed and long-wooled sheep. If the chief object be wool, the American or Spanish merino will be best.

SHEEP *vs.* CATTLE ON GRAIN FARMS.

76. This is a subject in which the *taste* and *fancy* of a farmer will be involved, when we inquire concerning the profits in rearing the different animals. It is important—as we have seen in a preceding paragraph under Mixed Husbandry—that either sheep or neat cattle should be raised on every farm in connection with growing grain. Therefore, if a farmer's fancy and taste incline to raising sheep, either for wool alone or for wool and mutton, more than towards raising neat cattle, he will succeed the best in raising sheep; and if he is what is colloquially denominated "a great cattle man," he will find it most agreeable, as well as most profitable, to raise neat cattle.

77. Raising either neat cattle or sheep will be found profitable in connection with raising grain, when the business is conducted according to the most approved system of management. If the clean profit is the paramount consideration, without any regard to a man's *taste* and *fancy* for sheep or cattle, then we can give a few leading thoughts on this point, which will be appropriate to this chapter, provided every part of the business is conducted according to the details alluded to above. It is impossible to state whether neat cattle will be more profitable than sheep until we know something of the breeds of each kind of animals, and the prices of mutton, wool and beef. If a farmer be required to operate on borrowed capital to a certain extent, and he desire to make prompt returns in a limited time, sheep will be better adapted to his circumstances than neat cattle or horses. The reason for this is obvious. Sheep will furnish an annual revenue from the sales of wool and mutton; whereas it will be more profitable to keep young cattle until they are three or four years old before they are sold for beef.

78. Many farmers contend that sheep will be more profitable than neat cattle on any farm, and under all circumstances; and this coincides well with my own experience, if the right breed be selected. Of course this includes not only profits which will accrue from the sales of wool, mutton and beef, but the advan-

tages arising from the fertilizing matter that will be left by sheep and neat cattle, which will go to improve the fertility of the soil.

THEIR EXPENSES AND PROFITS CONTRASTED.

79. It is safe to assume in the outset, that a farmer can take care of one or two thousand dollars' worth of sheep, with less labor and at less expense, and get quicker returns in trade, than he can if his stock consists of one or two thousand dollars' worth of neat cattle. Now, allowing that all the resources for manure and fertilizers are carefully husbanded, whether one keeps neat cattle or sheep; and allowing that each kind of animal will be constantly abstracting fertilizing matter from the soil for making bones, mutton and wool, or bones, hair and beef, the difference will not amount to any definite sum in favor or against either kind of animal.

80. Sheep will appropriate the bone-forming material of the soil which consists of phosphates, to make their wool, bones and mutton; and neat cattle will require a much larger supply for the formation of comparatively larger frames. But when we come to take into consideration the labor and food required to keep each kind of animal, there will be a difference in favor of sheep. During the foddering season, a thousand dollars' worth of sheep can be cared for and protected with comfortable sheds, and fed with stalks, straw, hay and grain, at a less expense than cattle. For feeding neat cattle and horses, grain must be ground very fine in order to obtain all the nourishment from it that it is capable of yielding. But for feeding sheep—unless they have poor teeth—it need not be ground, whether one feeds peas, Indian corn or oats; as sheep will masticate every kernel in a thorough manner. But neat cattle and horses will not do this. Therefore, here will be an additional expense of grinding the grain, when cattle are kept. But during the summer, sheep will require much more attention than cattle.

81. On a grain farm—so far as my own experience has extended—the straw of the cereal grain, the cornstalks, coarse grain, and hay, may all be worked into manure with less labor

by keeping good sheep than with neat cattle or horses. By feeding a flock of good wethers or dry ewes one pound of oil meal each daily, or one pound of Indian corn, and all the good straw they will consume, with a little hay or cornstalks, they can be kept during the winter with a little labor. And with this amount of feed they will thrive well, and make excellent mutton after they have been allowed to feed on grass for ten or twelve days. The great difficulty in keeping neat cattle will be in getting a herd that will be as equal in size and feeding qualities as a flock of sheep. For this reason, every animal must have a separate stall; and perhaps a little different feed. Then there will be the stalls to clean out and to litter every day, which will require no small amount of labor to keep every thing in proper order.

BEGINNING FARMING OPERATIONS—FRUIT.

82. One of the first jobs which a farmer ought to perform, when he commences farming operations, is planting fruit trees, especially apple trees. A man wants fruit of all kinds for his family; and if he should raise more apples than he can dispose of advantageously, they will be about as profitable as grain—when fed in connection with it—for sheep, neat cattle, horses and swine. All of these animals like apples; and they will often be of more value, when consumed by stock, than to sell in the market. As we do not propose to give details concerning the cultivation of fruit of any kind, we must refer the reader to some of the leading works on fruit culture, of which quite a number have been published, and which cover the subject. There is one consideration, however, that it will be well to mention in this place, which is selecting such varieties as have been found to succeed well in that particular locality. But after a man has selected his varieties; the true way is to go to the nursery, and get the trees and transplant them as soon as may be practicable. I have seen so much carelessness and disappointment in procuring fruit trees, that I always caution every one against purchasing them of itinerating dealers. It will require but a short time to destroy the vitality of a fruit

tree or vine, if the roots are exposed to frost, sunshine, or drying winds.

83. Let all fruit trees and vines be selected and dug up, and transplanted with great care and despatch; and then, let the soil be kept well cultivated around them, and good fruit may be raised in a few years. The soil needs to be well drained, either naturally or artificially; and to be pulverized to a good depth ; and kept mellow on the surface. These things will be far more important than manuring highly.

STOCK ON DAIRY FARMS.

84. On a dairy farm, the leading consideration will be to obtain such cows as will yield not only the largest *quantity* of milk, but those that will produce the greatest amount of butter and cheese from the smallest quantity of feed. On this subject a farmer will need to avail himself of all the experience and good judgment of men of larger observation and extensive practice, coupled with his own good judgment and knowledge. There is as much difference in cows as there is in breeds, both as it respects the *quantity* of the milk which they will give as well as the quality. Where it is no object to raise calves, but simply butter or cheese—something may be done towards selecting such cows as will do much better on a poor soil than on soils that are very fertile and will produce large grass. There are thousands of acres of land in almost every State where the soil is thin and not very productive, even for raising grass, which are denominated "dairy farms." Now, on such soils there is no breed of cows that will equal the "Native breed" of New England and New York; and a good farmer would endeavor to secure such cows as will the most nearly answer the purpose for which the native breed were so well adapted, and it would be profitable to bestow some care in the selection.

85. Durham cows should be avoided for such localities; and even Devons will not be found to be most profitable in such places, although they will be more profitable than Durhams. Bear in mind that some little, raw-boned, narrow-chested, homely

cow will often yield more cheese or butter than two other costly animals of beautiful form and symmetry. Then, if the soil is rather poor and thin, a good Alderney cow, or one of the Ayrshire breed, or a cross between these breeds with a full blooded Devon bull, will doubtless secure a cow for dairy purposes of superior excellence. Such cows will succeed well on the best of soils; but their great excellence will appear, when confined to inferior soils, where thorough-bred Durhams, or cows of some larger breed, will not be found as profitable. But young farmers must not cherish the erroneous idea, that any kind of cows will yield a large flow of rich milk, for either butter or cheese, when they are required to subsist on daisies, sorrel, and other coarse herbage. Cows must have good feed in order to make good milk in large quantities.

86. Those cows that show every rib when they are giving a full flow of milk, may be entered on the list with those that we know by actual trial to yield more butter, more cheese, and generally better calves, than those that will keep as fat as a young bullock. The truth on this point is, if a milch cow secretes all the butter-forming material in forming fat and flesh, she cannot yield much rich milk. And if she yield a liberal flow of rich milk, she will almost always be very thin in flesh. This is an excellent test of good milch cows, when they have been well kept.

SELECTING TOOLS AND IMPLEMENTS.

"A pitch-fork and dung-fork, a sieve, skep and bin,
A broom and a pail, to put water therein;
A hand-barrow, wheel-barrow, shovel and spade,
A curry-comb, blanket, and whip for a jade."

87. It is an old maxim, that "almost any one can perform a piece of work if he has the tools; and that it requires an expert mechanic to work without tools." But farmers must have tools and implements that are adapted to their business, or they cannot make any progress in cultivating the soil. It is very difficult to make one tool or implement subserve more than one good purpose. For this reason, farmers find the expense of tools and implements one of the greatest drawbacks in all their farming operations.

88. In former days, when manual labor was cheap, farmers were not required to invest so much capital in farm tools and implements. But scarcity of laborers, and high wages, have compelled them to purchase tools and implements with which their horses may perform their hard labor. Without enumerating what tools a farmer needs, we will make some practical suggestions concerning their mechanical construction and adaptation to the end for which they were designed. The great and leading idea should always be, to select those tools that are most simple in their construction. Such machines are almost always the most durable, the cheapest managed with the least difficulty, and the most effective. A tool or implement that is as complicated as a twenty-four hour clock with a second-hand on its dial, will too often require a machinist and a machine-shop along with it to keep it in running order. Read the Rules for Selecting Plows and other Implements in Vol. I., giving full directions for the selection of good farm and shop tools, their use and manufacture.

89. Another thing is, to procure such only as a farmer can use with his own forces. When a man is under the necessity of rallying a numerous force of men and horses from among his neighbors to perform a small job, he will always find that it will absorb too large a proportion of his income to defray the expenses of such large forces. On small farms, in order to make farming pay, a farmer must calculate to do his own work as much as may be practicable. I always considered it poor policy to hire teams and laborers, at exorbitant prices, to perform labor that my own team and hands could do by being a little longer about it.

RULES FOR SELECTING TOOLS.

90. In selecting a subsoil plow, for example, I always selected one that I could draw with my own team, instead of choosing one so large as to require all my own teams and a portion of my neighbor's to draw it. Then every stick of timber and piece of iron in it would be scrutinized to see if they were all sound and right. The timber should be of the first-rate, second-growth, white oak or white ash, or some other tough and hard wood, and free from

knots and cross-grained places. I always looked with suspicion on "the gold and glitter"—the nice paint, the beautiful pencilling, bronzing and varnishing. All such things increase the expense of a machine; and, with the crowd of farmers, they often eclipse the merits of an implement. Manufacturers understand this point very well. They know that a few pennies' worth of paint and varnish will often make a good sale for an inferior implement.

91. Two men can perform almost any kind of labor on a farm, if the management is only right. Instead of employing a ten-horse power to do my thrashing with, I selected a two-horse power; and by having my machinery properly disposed in the barn, one boy and myself, and two horses, always thrashed the grain, cut the straw, cornstalks and hay; sawed the wood with either the drag-saw, when sawing logs, or with the circular-saw when sawing cord-wood. The horse power stood on the first floor, and the thrasher on the second floor. Stables were in the basement. Now when we hauled buckwheat or barley from the field, one man would pitch it to me as I fed it through the machine; and the straw of ten or twenty bushels of grain would be carried away by horse power. Or, one man or boy would unbind the sheaves and bring them from the mow to the machine. With the same machine and help, my clover seed was thrashed and hulled; and with two horses and a boy I would shell my Indian corn, and clean it at the rate of seventy bushels per hour, by the clock. By having such tools and implements as two men and two horses could work with, all my thrashing appeared to cost but a trifle in comparison to what the expense would have been had it been done by a large machine, with a large gang of hands and horses. According to one system, the expenses will be large, but the job will soon be done; while according to the other system, steady and profitable employment will be furnished for both horses and men, and a large bill of expense saved. Read Appropriation of Forces of the Farm, in Vol. I.

92. In selecting hand tools, my aim was to understand first what I wanted—how a tool should be made—and then select

the one that would approximate the nearest to what my ideas were of a perfect tool. Simplicity of construction, durability, efficiency of operation, substantiality, and managability are all important considerations in the selection of any farm tool or implement. Wherever tools and implements are illustrated or described in the "Young Farmer's Manual," in either volume, their excellencies will be noted.

WHY TOOLS AND IMPLEMENTS NEED PROTECTION.

93. I have heard it remarked, scores of times, that "those implements are all iron; and it will not injure them to be exposed to the weather." But it *does* injure tools to be exposed to the influences of the weather, even when they are made entirely of iron and steel; and it is not unfrequently the case, that the weather uses up more tools and implements than the work which they do. Let a shovel, spade, broad-hoe, or any other similar tool, be exposed to a long storm of rain, and sunshine afterwards, and in many instances a scale of rust will be formed on the surface so thick that it will peel off. Now, it would require much more use than we are wont to suppose to wear off as much of the surface as the thin scale of rust would destroy. And besides this, a rusty, rough surface will often render a good tool inefficient in its operation; and much more force will be required to use it. This is particularly true of plows, cultivators, and the tools already mentioned. And, in addition to the injury that the iron and steel receives, the wooden portions swell and shrink by being exposed to wet and dry weather. When the surface of wood is wet with water, it raises the grain of the wood; and when it is dried, either by sunshine, fire or wind, the grain never settles back again as firmly and as smoothly as it was before it was wet. This renders the surface rough. And further more, every time the surface is wet, the rain dissolves and washes out a small portion of the soluble part of the wood. This suggests the importance of covering the surface with a coat of good paint that will exclude the wet, and thus keep the surface from expanding and contracting.

94. The bearings and the boxes of mowers, and reapers, and other kinds of machinery, have often been fitted up with so much care that one can see the color of his eyes in the neatly-polished surface. By having the surface of such parts of machinery very light and smooth, much less power will be required to work it. Now, if a machine be exposed to rain and sunshine, these polished surfaces will become rusty very soon; and this rust will not only make them run hard, but it will frequently make a bearing wear out very fast. And if it causes it to wear only a little, the wear will increase more and more the longer a machine is used. My own practice always was to have every tool and implement washed and wiped clean and dry every day, as soon as it was not needed for immediate use, and put in a dry place. And the polished surfaces of such tools as plows, cultivators, shovels and broad-hoes were always oiled with any kind of oil that did not contain salt to prevent them rusting. Salt grease or salt oil will corrode a polished surface much sooner than rain water.

KEEPING TOOLS IN ORDER.

95. The *wooden portions of wagons, sleighs, harrows,* and all other kinds of farm implements, by a constant use will need repairing, and many times a break-down may be avoided by a little care and forethought. As repeated strains are brought to bear on the various parts of an implement, the joints will render a little; the heads of bolts will be crushed a little into the wood; nuts will start loose a trifle, and be constantly working more loose; so that the first thing we know is, a nut is gone; and a serious break-down follows. We often see good vehicles and implements working, jingling, rattling to pieces, from utter neglect to keep them in ordinary repair, which would occupy no time at all comparatively. I will illustrate my ideas.

96. All my vehicles—when I was farming—were examined several times a year; and the nuts, rivets and bolts tightened up as soon as one appeared at all loose. Every time an implement was taken from the tool house, every nut, and bolt and key would be examined closely, to see if they did not want to be screwed

up or keyed up. And every two or three years the sun cracks would be puttied up, and the surface covered with a good coat of paint. Thousands of dollars' worth of tools and implements rust out annually, which would do good service for many years to come were they protected from the weather and kept in proper order. The condition in which tools and implements are kept, furnishes a correct index to the true character of their proprietor in point of business habits—promptness, efficiency, industry and faithfulness. And if a farmer desires to have good and effective tools and implements, he must not only protect them from the influences of the weather, but keep them in good repair mechanically.

INJUDICIOUS MANAGEMENT.

97. In case a farmer does not care to labor only a small portion of the time, let him employ implements that will require a large gang of hands and horses to work them. But this system of management is nothing more nor less than having a man to perform a day's work that one might do as well as not, instead of remaining idle. Thousands of farmers shell a few hundred bushels of their Indian corn in this expensive manner. They employ a man with a ten-horse power, with two or three men to shovel in the ears; one to pitch the cobs away; two to shovel away the shelled corn; two men, two wagons, and four horses to haul the shelled corn to the barn; one to drive the horses on the machine; and usually one or two to look on. The aggregate expense I will not foot up here, as the reader can do it himself.

98. So it is with many other operations on the farm. The management is decidedly faulty. If our good wives and daughters should invite in a large circle of their neighbors to help them cook up bread, biscuit, pies and cakes enough to last the family from July to January, we should at once condemn such a practice as wasteful and unnecessary, not consistent with the duties of a judicious and careful manager of household affairs, and calculated to bring reproach on all who should be guilty of such foolish acts. It is a farmer's business to man

age well; to wed the hands to industrious labor and the head to useful knowledge.

99. Merchants, mechanics, and men who are engaged in other business, if they are successful, are required to attend strictly to it every day, from the end of one year to the other. And they are called bad managers if they fail to do so. And it is equally true of the farmer who employs a gang of laborers to finish up a job of work in a few hours, and at a busy season of the year, when his own teams and own forces would be able to do it by and by, as well as to remain idle. It is decidedly bad management to keep teams and laborers at even a low price, and then hire the work done, that they could do as well as not.

100. The practice which the large proportion of farmers adopt, of thrashing their grain at the latter part of harvest time, when the other labors of the farm are very pressing, and when wages are high, is very objectionable for several good reasons. And there is not much ground for justifying the practice. The objections to this practice are, it is more expensive; because it is done when wages are high and help scarce. Another thing is, a large amount of the straw will be wasted, which might otherwise be fed out to sheep, and thus worked into mutton and good manure, by which the fertility of the soil would be maintained. Therefore we see that all of those bad systems of management will have a direct or indirect influence on the fertility of the soil.

HORSES *vs.* OXEN FOR FARM TEAMS.

"And horses or a yoke
Of easy oxen, with long-swaying gait,
Their large eyes dreaming o'er the rolling cud,
Convey the winter stores into the barn."

Read's New Pastoral.

101. Why is there so little labor performed by oxen, when compared with the amount that is done with horses? Because young farmers, boys, and hired men dislike an ox team. And why this dislike? Because they do not understand how to drive oxen. And if a man is unskilled in driving oxen, an ox team is a very disagreeable team to manage. On the contrary, if a man knows how to manage oxen, an ox team is

a very agreeable team to use, not only for plowing and harrowing, but for every branch of farm labor. Most of our young men dislike oxen because they cannot *ride* so conveniently as they can with horses. When they go to and from the pasture, they must ride. When they go to the field to work, they must ride; and if an implement will carry them, they must ride on it. If they are to haul a load of any kind, they must ride, or they don't go. They must ride to their neighbor's, and they must ride to mill. They must ride to the post office, and they must ride to the blacksmith's shop. They must ride to the well to get a drink, or have a boy to fetch it to them, and they must ride to the dinner table, and ride to bed. And if they have horses they can do it. But if oxen is their team, as they are not skillful enough to drive them while riding, they are compelled to foot it. Therefore oxen for a team are disagreeble to manage; and, in their estimation, are not fit for a team at any rate; and they are unwilling to use them, because they can't ride every rod.

THEIR EXCELLENCIES COMPARED.

102. When travelling on the highway, with a light load, horses are preferable to oxen; because they can go and come quicker, and with less fatigue than oxen, and because they are better adapted to travelling on a trot than oxen are. This is the only consideration of any real importance in which horses are superior to oxen for a team. For plowing, harrowing, hauling manure, hay, grain, or loads of any kind about the farm, and for hauling loads only a few miles, oxen that have been properly broke in, and kept as oxen should be kept, will plow as much land, haul as many tons in a given period of time, as a span of horses.

103. Let a yoke of oxen be cared for throughout the entire year as well as horses are, and they will usually perform more hard labor, and keep in better condition than a span of horses. It is not the work—the hard labor—that injures oxen. They are made for the very purpose of enduring hard labor. But it is this incessant, detestable bawling and whipping, and goading, and

worrying, by awkward and unskillful drivers, that uses up the fat and flesh of well-fed oxen. When I was in my teens, a hired man would usually go with the horses, and I with the ox team; because I could drive the oxen day after day, at plowing or any thing else, and keep up with the horses, with ease to the oxen; but he was not able to do it. And whenever I kept an ox team on my farm—as I did most of the time—they always kept pace with the horses, at any and every kind of work, even in the heat of summer. The great secret of the excellence of oxen in the above cases was in using them gently, and in feeding them well. I always found an ox team the most agreeable of the two for doing almost any kind of farm labor. An ox costs only about half as much as a horse. Then, you can feed an ox on grain all the winter, with the assurance that it will not be lost. In case he gets a leg broken, his flesh, tallow, and hide will bring as much as if he had been fattened expressly for the shambles. There is seldom anything the matter with an ox when he is well cared for.

104. But if you have a valuable horse, it will cost a vast deal of time to take care of him, and an enormous amount of grain and hay to keep him well. And the first thing you know, he will lie down, and kick up, and die, without even permitting you to know that he was sick. Or he will have the glanders, the yellow water, the bots, the inflammation of the lungs, or the something else, which will baffle all the skill of veterinarians; or a spavin will spring up, unbidden, on one leg; or a ring bone will adorn the other; or he has strained a joint somewhere or somehow—no mortal can tell how, nor when, nor where. But nothing of the kind occurs to oxen. Only feed them well, treat them kindly, give them a comfortable place to lie down in, where they may enjoy quiet rumination and rest, and faithful old Buck and Bony are always on hand when the roll is called.

105. Deliver your lines to a careless man or boy, and the first news will be: "The horses have run away, and made kindling wood of the wagon, torn the harness to tatters," and, perhaps, ruined themselves. But let Buck and Bony be placed in the same circumstances, and you will find them standing quietly [illegible]

places, waiting for further orders. Attempt to drive through the deep snow with your horses, and, if they cannot walk or trot smoothly along, down they drop, and there they will lie. And, ten chances to one, if they do not wound their feet and legs almost incurably when floundering in the snow, and acting more like a beast of no intelligence than like a sagacious horse. Get them in the mud above their fetlocks, and down they go again; and it may be you can unhitch the traces, and unbuckle the harness, so as to enable them to rise; but if you cannot you can cut it to pieces. And then faithful Buck and Bony must pull them out, and haul out their load also. "O, nonsense, perplexity and vexation personified!" you exclaim. "Put up the horses into the warm stable, and close the ventilators, and rub them dry, and buckle on their blankets, and give them a half bushel of oats each, and don't take them out again until the weather is decent. And let the oxen break the roads, and try the miry way."

106. Now, "Buck and Bony, can you go through that little drifty heap?" "Bah, bah!" and away they go like a steam plow, or wallow like a dog. Sometimes they rest upon their *feet, and sometimes upon their bellies. But still they go on cooly,* quietly, steadily; and, if a little fatigued, they don't drop down on their butts and keel over, one on the top of the other, as horses do. No, by no means. They go on every time the word "go" is given. And when they have returned to the stable all jaded out, only give them a good feeding and a good bed, and they will grow fat on it. And the heaves, bots, yellow water, founder, or distemper touches them not.

107. Again, hitch the horses to a huge rock or log, and, if it don't start right along, look out for floundering, rearing and pitching, balking and jerking, and broken harness or whiffletrees, without so much as moving the load a single foot. But only hitch on the oxen, and, at the word, they pull with all their might, just like a man, not once only, and then back up, and flounder, and balk, and refuse to move after they have been unhitched, but they will pull seventeen times; and, if the load is drawable, they will fetch it at last.

OXEN SLOW IN THEIR MOVEMENTS.

108. When steers have been correctly broken in, they will keep close up with horses as long as they travel on a fast walk. But the course that is usually pursued with young oxen is the most successful way to make them intolerably slow. They are hitched to a huge, lumbering cart, heavy enough for a single team to draw without carrying any load, and, whanged around with it, day after day, often being compelled to carry a good portion of their load on their necks, and hold it for hours without any relief. Such usage, with unmerciful kicking and pounding by human stupidities, who have less intelligence than the oxen they drive, destroys all their elasticity and spirits, and soon makes them like an old, broken-down dray horse that moves like a bug in a tar barrel.

109. S. A. Law says: ' A common objection urged against oxen is, that *they are constitutionally slow of motion*, and not to be depended upon in the hurrying operations of the farm. The fault is not a constitutional one, but the effect of injudicious training. The common method of *breaking steers* tends to make their movements slow. They are usually put into the yoke when two or three years old, and fastened to a yoke of old cattle, rendered slothful by labor, where they are worked until ' broken,' and forced to accommodate their movements to the tardy motion of the team that controls them. After having been tamed and rendered obedient in this way, they are usually put to labor quite too severe for their age and strength, and soon become ' broken' in spirit. It is not strange that under such treatment oxen are sluggish in their movements."

110. The Devon breed of cattle has ever been esteemed for its working qualities, being excelled in speed, at the plow, or even upon the road, by but few horses; and, in their native country, it is said they are not unfrequently *trotted*, with an empty wagon, at the rate of six miles per hour. From this valuable stock many of the working oxen of New England are believed to have arisen—their color, form, and action [illegible]

their origin. Well directed experiments have demonstrated that, with proper treatment and training, the difference in speed between horses and oxen, in farm labor, is very little. Sir John Sinclair says, that the ox teams upon the farms in Wooden and Mellendean, *when along with the horse plows, never lose a turn.* The issue of plowing matches throughout the country has, it is believed, established the fact, that oxen can plow a given space of ground *as quick and as well* as horses. In the early history of this country, when the roads to the Hudson River were new, passing through forests, and surmounting many of the steepest hills, my father employed heavy ox teams upon the roads in his farming and lumbering operations. His ox teams, heavily loaded, going and returning, made their trip to Catskill, a distance of 66 miles, in *six days.* Horse teams consume, *on an average,* the same length of time now—travelling over roads, for the most part carefully graded and well worked—roads ten miles a day easier for a team than those in use from 1800 to 1812. The heavy six-horse teams travelling upon the National Road make but fifteen miles a day. Ex-Governor Hill, of New Hampshire, says: "I have, at this time, cattle of my own raising which have been taught to step quick; and, having worked in the same team with horses, will travel as fast and plough as much in a day as the same number of horses. A pair of these oxen will plow from one and a half to two acres in a day, working eight hours. Oxen well fed with hay, and a portion of Indian corn or meal, will, in the heat of summer, stand it to work daily from eight to ten hours."

111. It occurs to me, at the present writing, that the last yoke of oxen that I owned was broken by myself, and no one was allowed to drive them but myself; and they would go to the saw mill with a heavier log than the horses hauled, and return promptly with them. And, for many successive days, when they were excellent beef, and were eating over one bushel of corn meal per day, they plowed with narrow furrow slices more than one acre of ground daily, and cut a deeper furrow than the horses, and never lost a round. And when I drove them five miles to market they outwalked the horses—which were good walkers—

more than half a mile. But their spirits had never been broken by a huge ox cart. Another objection urged against oxen is:

OXEN CANNOT STAND THE HEAT.

112. So far as my experience and observation have been brought to bear on this subject, this objection is not well grounded. There is no fairness in condemning a thing before it has been allowed to have a fair trial, under favorable as well as unfavorable circumstances. A correspondent of the *Country Gentleman* says: "It is a common practice with farmers, during the hurrying season of farm labor, to grain their horse teams, and take such other care of them as tends best to strengthen their powers of endurance; while it is a like common practice to *feed no grain to their oxen*—tasking their utmost energies in field labor during the day; and then leaving them to seek in the pasture, between sunset and sunrise, a restoration of their exhausted powers. Such oxen are often found *lolling* in the forenoon; and are pointed to as an illustration of the fact, that oxen cannot endure heat! Smarting under the lash, irritated by the bawling of an inexperienced and cruel driver, with a hot sun over him, and a stomach filled with green fermenting food, the ox faints at his labor, and very wise lookers-on shake their head and say, "he can't stand the heat." Sage conclusion, very! In India and China, in the West Indies, in South America, in Spain, everywhere under the tropics, oxen are used for draught, or as beasts of burden, and their powers of endurance are as great or greater than those of horses.

THE EXPENSE OF OXEN *vs.* HORSES.

113. Notwithstanding I hinted at the expense of the ox and horse teams in a former paragraph, (108,) I have thought it important to sum up the expenses of each team, so that the reader may see at a glance how they compare in cash value. Allowing the original purchase of a span of horses to be three hundred dollars, their harness, whiffletrees and neckyoke forty dollars, we have $340 00; while a yoke of good oxen—not the most valuable—will cost one hundred and fifty dollars, and their

yoke and chain about eight more, making $158 00. I have not computed the prices of the best horses, nor the best oxen, but only those of an ordinary quality, for the purposes of a team. Then the expense of *keeping* an ox team and a horse team will be very different, with different farmers. I have seen it stated, by writers on this subject, that the expense of keeping oxen and horses will be about as two to three; or, in other words, "it will cost one third more to keep a horse team than an ox team, when each performs the same amount of labor."

114. But this estimate does not coincide with my experience. I am willing to concede, that if an ox team and horse team were restricted to a limited allowance, a yoke of oxen would wear out a span of horses in a short time, allowing the amount of feed and labor of each team to be equal. When they are fed with unground grain, as horses masticate the grain better than oxen do, it would require more to feed the oxen. But if it be ground into fine meal, the difference will be much in favor of the oxen; because, they will then extract more nourishment from the feed than horses. And, so far as hay and grass are taken into estimate, my experience is that an ox will consume quite as much hay and grass as a horse. And if the oxen are large, and horses not very large, the oxen will eat the most. I always found that my working oxen, weighing eighteen hundred pounds each, when they were plowing side by side with my horses, weighing only eight or nine hundred pounds each, would consume nearly twice as many pounds of hay, meal and roots—and lick their mangers for more—as the horses.

TRAFFICKING IN WORKING OXEN.

115. I am personally acquainted with a good farmer who gave me the following facts, but protested against using his name. In the winter of 1864 he purchased a yoke of oxen for two hundred dollars. As he was a good feeder, he kept them thriving constantly. They did all his plowing, and hauling his manure, on a farm of seventy acres. In June he sold them for two hundred and sixty dollars; and the same day purchased

another yoke for one hundred and ninety dollars. After keeping them a few months, he sold them also for beef, and purchased another yoke soon. By this system of trafficking, he cleared over three hundred dollars in one year on his working oxen. A practical farmer says in the *Country Gentleman*: "When a small farmer buys a yoke of oxen for what one good horse will cost, he most likely gets a yoke in the bargain; so that with the expense of a few shillings for a chain, he is ready to hitch on to anything and go to work. Then the principal part of his work being in the spring, he can, by giving them good feed through the summer, and pumpkins and roots, or a little grain in the fall, and perhaps the fore part of the winter, make them sell for beef for from $25 to $50 more than he paid for them. This course may be followed on all farms where a yoke of oxen can do the work; and in numerous instances the turning point between success and failure may be found in the choice of a team to begin with. If the money that it costs to buy and rig out a span of horses for business, and generally for riding around in more or less style, over and above the cost of oxen, had been paid on *the farm instead of having been paid for perishable property*, it would have made a great difference in the final results. I have succeeded on a small poor farm, where almost every one prophesied my failure; and where I am satisfied, that, had I tried to buy and keep a good horse team, from the commencement, success at the best would have been much more difficult, if not impossible. By following this course, and selecting oxen that are good feeders, it need cost but little, if any, more to make a yoke of oxen fair beef, than itwould to keep a span of horses in good condition; thus giving a profit of from $25 to $50, and sometimes even doubling the money on the oxen, while the horses are wearing out.

THE ULTIMATE VALUE OF OXEN AND HORSES.

116. The above view of the subject commends itself strongly to every farmer who keeps more than one team. When oxen are kept as an ox team should be, they will perform a vast

danger of breaking some part of the gearing. When a team is heavy, and move at a moderate gait, their momentum will do much towards keeping the load or draught in motion, whereas a *light* team will be required to do it with their muscles, which is the most fatiguing manner of performing any kind of labor.

WHAT KIND OF ANIMALS TO AVOID FOR TEAMS.

121. There are two kinds of animals, both of the horse and ox kind, that it will be good policy always to avoid, because they are unprofitable to keep, as well as disagreeable to manage. One of these kinds may be described as large-framed, overgrown, long-backed, pot-bellied, Shanghai-shanked, ill-formed, that consume vast quantities of food, and never become fat. Such animals *may* make good teams, so far as labor alone is concerned; but, as a general rule, their dispositions are not as agreeable as those described in a former paragraph. This holds good with both oxen and horses.

122. Another kind to be avoided is small, ill-shapen, narrow-chested, light and narrow behind, cow-necked, slender-limbed, dancing and prancing, and unsteady-gaited animals. Such animals are almost always hard keepers, as well as difficult to manage. It seems almost impossible to teach them to draw heavy loads steadily, and it requires constant care to control them successfully. If they have been idle for a few days, and if they feel a little refractory when they are hitched to a heavy draught, away will go your traces or whiffletrees, or something else, because they attempt to perform a portion of their labor by the *momentum* of their bodies, instead of doing it by muscular force. Read the preceding subject on this point. When a team draws steadily, a chain or traces, or small whiffletrees, will hold to haul a heavy load, that would not be strong enough to move it an inch in case a team should start with a jerking motion.

MARES *vs.* GELDINGS FOR TEAMS.

123. With some men there exists a deeply-seated prejudice against mares as a team for any purpose; and if they keep a mare

on the farm, she is kept for no other purpose than for breeding. But when a farmer has only a few acres of plow land, and prefers to keep a horse team instead of oxen, he can adopt a system of management with a team of good mares that will be more profitable, perhaps, than any other kind of team. The details of this system are practised by many successful farmers in the following manner; and when I commenced farming operations I practised it also: Obtain two good breeding mares, and endeavor to have them drop their foals before they will be needed to do the field labor in the spring; or, they may drop their foals a week or two after the spring labor has been done, and thus avoid the necessity of putting them immediately to work.

124. With proper management a man may raise two good colts every year, without any detriment whatever to his team or mares. But this affirmation is predicated on the supposition, that they will be used by careful hands. But, if they are to be slammed and jammed around by every Tom, and Pat, and Jim, that will use a mare as roughly as they would a wheelbarrow, such a team would be a very unprofitable one. In case a farmer desires to keep two teams of horses, it is a good practice, which many good farmers have adopted, to keep one team of breeding mares and another team of geldings, that will always be ready to perform the heavy work, and the mares with colts perform the light work. Two good colts annually will defray a good part of the expense of keeping a team through the year.

MULES *vs.* HORSES AND OXEN.

125. Some farmers have contended that mules will make the best and most economical team. But, after making inquiry with special reference to this subject, for more than twenty years, and, after reading with care and impartiality all that I have met with on this subject, I have come deliberately to the conclusion, that I would not have a mule team on my farm, because a yoke of good oxen will be infinitely more agreeable, as well as profitable, than mules.

126. The chief arguments for and against mules may be thus

summed up. They are longer-lived, tougher, will subsist on coarser fare, and endure greater hardship than either oxen or horses. On the contrary, it is said of them almost universally, that there are really but two suitable places for mules—the stable and the harness. They are not as tractable as either oxen or horses, and they are much more liable to be vicious—to kick, balk, and to be unruly in the field. If a farmer has an ignoble and outlandish set of drivers—such as were accustomed to drive mules in the Slaves States before the civil war commenced—who must, of necessity, kick and pound a team about so much every day, it would be advisable for him to obtain a pair of mules. My old primer used to say:

"A Dutchman rides a stupid mule,
A stubborn beast that few can rule."

WE MUST HAVE HORSES.

127. Whatever may be the expense of raising or of procuring them, most people must and will have horses. If they cost three times as much as beautiful oxen, horses must take the precedence. It appears to be utterly incompatible with the predominating characteristics of the people of this age to desire *to ride—to ride fast*—and, therefore, they want and will have those animals to draw them whose speed will be the nearest equal to the railroad cars. Men of extensive business, whose time is worth fifty cents, or one dollar per hour, need a fast horse to carry them from place to place; and it is right and proper that they should have horses that can travel fast.

128. But, says one: "We must have horses to cultivate hoed crops, and to rake hay with, and to perform many other kinds of labor, and to draw our carriages and families to meeting and to social gatherings." But oxen would do all this, if it were only the *fashion* to ride after them. If it were only the *fashion* for a man to have his pleasure carriage drawn by a Durham bull, or by a fat steer, instead of a horse, then it would be as droll and odd to ride after a horse as it now seems to savor of oddity for a female to be seen destitute of hoop skirts or long-trailing dresses.

Americans must and will have horses, whatever the expense may be.

MAKE YOUR HORSES PERFORM YOUR HARD LABOR.

"Honor to labor, it giveth health;
Honor to labor, it giveth wealth;
Honor to labor of body or mind,
Which hath for its object the good of mankind."

129. No intelligent farmer has any business to perform heavy labor with his hands that can be done conveniently with a horse, or with oxen. Horses are made to labor—to do the bidding—the drudgery—the toil—in fine, to do the service of mankind. They are good for nothing else only to help us work; and if we do not lay out the work for them, they are nothing but a bill of expense. The Creator knew well that we need some strong and obedient animals to carry our burdens, and carry us; therefore He gave us the horse, in whom are combined more desirable qualities for a team than can be found in any other animal. Let us endeavor to honor our calling by bringing our horses more effectually into our daily labors.

130. One horse is calculated—in agricultural dynamics—to be equal to about five men. But, at many kinds of labor, a span of horses will perform with ease more than twelve strong men, even when the men labor very hard. Where, then, is the propriety of keeping a span of fat horses, capable of performing more than ten men in a day, and letting them stand idle, and see a little, feeble man toil ten or twelve long hours to perform what they could do with ease in less than *one* hour? It is almost a wonder that some of our teams do not speak out, like Balaam's ass (Num. xxii. 28), and rebuke us for our unaccountable stupidity; and ask the privilege of working a little every day at something, which would afford them healthy exercise, and bring great relief to their owners. We all have minds to care for, as well as bodies; and the man who neglects the proper cultivation and improvement of his mind, and distinguishes himself in the world only by making a horse of his body, wrongs himself, his friends, his country, and his God. A man is the very highest order of intelligent beings,

and he should maintain his superiority by laying out labor for his horses, that are given to him for servants. Horses can turn the grindstone, do the churning, pitch our hay, hoe our corn, dig our potatoes, and do almost anything else, and do it with ease, and keep fat too, if we will only *think* for them, and give them the word to go ahead and to stop. Our business is to think, and it is theirs to do the work.

131. When I see a little man lifting and lugging, and sweating and tugging, hour after hour, to get a few tons of hay on to a high mow, while he has two fat horses standing idle, which could elevate it in a few minutes, I always think what a dunce you are to make such a beast of burden—such a long-eared jade of yourself—when the Creator has given you such strong animals to perform your hard labor! You are frustrating the design of the Almighty by making yourself a horse, when he intended that you should reflect the image of the Creator, and exercise dominion over the beasts of the field, and require them to perform your menial service!

REARING IMPROVED STOCK

132. Lies at the foundation of all progressive agriculture. It does not cost as much to fat a pig of some improved breed as it will to fatten one of the alligator or landpike breed, whose snouts are long enough to reach through the fence to the second row of corn. And this branch of agriculture ought to constitute one of the principal sources of profit to the farmer. If a farmer occupies a dairy farm, and his chief object is milk, for either cheese or butter, he will find it a source of great profit to obtain the best cows for milk. And, in connection with this branch of business, it will be good economy to fatten a few swine annually which should be of the very choicest breed. Fattening pork and dairying are intimately connected, as swine are needed to consume the butter milk and whey.

133. Again: if a farmer prefers to raise sheep of any kind, either for wool or for mutton, or both, economy would dictate that he should obtain such animals only as will be the best adapted to the object in view. The best is, in all cases, the

most profitable for either of the purposes; and if he desires to raise good horses for market, or neat cattle for the shambles, the first step should be to dispose of every breed of an inferior character, and then obtain such only as possess excellent characteristics for the purposes intended. If farmers take pains to breed from the best animals, and to rear them in the best manner, they will always be sure of the best price for them, providing they fix that price on them at the time of sale.

I have space here only to caution farmers against a very common error all over our country at the present time, of employing grade male animals in raising stock of any kind. By using the services of full-blooded males—either stallions, bulls or bucks—the progeny is, almost always, very good. But by selecting males from their progeny for propagating their kind, the improvement will be of a retrogressive character.

134. A few years ago, many farmers employed the services of a full-blooded Durham bull with their common cows; and the improvement always exceeded the anticipations. Had they continued as they commenced, they would have succeeded well. But after taking one good step in a good direction, they stopped, and commenced breeding from an inferior animal. This has been the case with sheep as well as with neat cattle. Let it be remembered, that in order to be successful in rearing improved stock of any kind, it will be important to breed from a thorough-bred male, that will transmit his excellencies to his progeny with great certainty, and not to breed from a grade male animal of any kind.

WHAT A SMALL FARMER MAY DO.

135. In order to show that something tangible may be done at rearing improved stock, I transcribe a paragraph from an address, by Hon. Geo. Vail, by which it will be seen how sooh a farmer may raise up a herd of the very choicest animals: "For this purpose I cordially invite farmers to call at my farm and examine a cow of the Durham breed, which I purchased in the month of May, 1858, for $125. The animal I allude to was then a two year-old-heifer, with a heifer calf at her side, dropped a few days

previous. From this heifer and her then calf I have raised six calves-four heifers and two bulls—making this stock now eight in number. Three of them are now with calf, with a promise of increasing the number to eleven animals the coming spring. I make this statement simply to encourage such farmers as decline raising improved stock, on the ground that it costs too much money to make the first purchase, to prove to them that with an outlay of $125 they may in four or five years rear a pretty large herd, as to numbers, provided they do not dispose of any of the increase. While rearing an improved herd, they can dispose of the old animals to make room for the the new herd."

CULTIVATING LARGE *vs.* SMALL FARMS.

> "'Tis folly in th' extreme to till
> Extensive fields and till them ill;
> For more one well-tilled acre yields
> Than the wide breadth of half-tilled fields."

136. I believe that farms are very apt to be too small for profitable cultivation. I know that large farms are seldom cultivated as well as small ones are; and they are seldom proportionally as productive as small ones. But where is the cause of it? Who, or what, is in the fault? It is not, certainly, in the *soil*, but in the cultivation of it. Suppose we divide a large farm into several small ones, and let different proprietors own and cultivate it. As a general rule, the productiveness of the soil will be very much increased in a few seasons. And why? Simply because it is cultivated more thoroughly than it was when it all belonged to one farm.

137. The *expense* of cultivating small farms is often much greater proportionally than the expense of cultivating large farms. And were it not for this single consideration, we should coincide with those who advocate cultivating small farms in preference to large ones. Let us particularize on this point. A farmer must have a good team, and a full set of tools and implements, whether he has one acre or one hundred to cultivate. If his farm is small there will be many implements, very essential, which will not be used more than one or two days in a year, the use of which will

not be an equivalent for the interest on their cost. This will be found true of a grain drill, mower or reaper, and some other implements. Then, if the team consists of horses, they must be kept well, whether there is any work for them to do or not. But if a team consists of oxen, they will be improving in value whether they work or not. But with a horse team there will be a much greater expense, proportionally, on a small farm, than on a large one, on account of the expense of keeping a team in idleness.

138. If a man desire to keep stock, his operations will always be contracted and cramped, if he have a small farm. A man will take care of one hundred sheep in about the same time that will be required to take care of only ten. And unless he practices the "soiling" system— keeping them in a stable or yard— the expense of a small farm will usually be much increased by fencing the farm into smaller fields than are necessary on large farms. The only plausible objection to large farms is, farmers are quite too apt to attempt to perform more than can be done in good time with the limited amount of help which they employ. If the soil of large farms were to receive the same attention, the same amount of manure per acre, and the same amount of good cultivation, it would be most profitable to cultivate large farms.

CONFIDENCE IN THE SOIL,

139. And confidence in one's ability to cultivate it in such a manner as to make it pay well, and at the same time keep it good, is what American farmers need more than anything else. When farmers are about to commence a system of improvement by underdraining, there are but few, comparatively, who really feel confident that the expense will all be returned, with double interest, in a short time. So it is when they apply fertilizers. They are distrustful, and filled with serious apprehensions that "it will not pay" after all. This want of confidence in the soil too often induces them to slight a good job, because they have not that confidence in the productiveness of the soil which is essential to success. (See this subject more fully elucidated in the Chapter on

the Management of Soils.) A practical farmer of New England writes: "What is required to accomplish the needed reform in the modes of management upon New England farms is, *more faith in the land.* The cultivator must come to a realizing sense that *profit*, which is the sum and substance of success, comes not so much from the careless cultivation of a large number of acres as from the *thorough* cultivation of a few. And in that word "thorough" is included everything which relates to managing, pulverizing, and clearing the land. There are what are called "small farmers," cultivating from eight to ten acres of land, whose annual return in cash would excite the envy of many who cultivate our largest farms; and yet they accomplish such results under greater disadvantage than the large farmer, who achieves little in comparison. They do not hesitate sometimes to bestow upon the land, in a single year, manure to the full value of the land itself; and they seldom fail of their reward, in the shape of immense crops; while the old-fashioned cultivators are toiling over a vast surface to gather the scanty products of the old system."

SMALL FARMS AND BETTER CITIZENS.

140. Although it may be less expensive, comparatively, to cultivate large farms, still there is another consideration of more noble importance than simply dollars and cents, which every good citizen must admit to be a worthy object, which is, the improvement of the *farmer himself* as well as his soil. Could our country be divided up into small farms—say about fifty acres each, and be occupied and cultivated by men with their rising families, we should not only see a marked improvement in the productiveness of the *soil*, but in the farmers themselves, when taken as a class. If a man will be satisfied with a good competence—with a good living—with having in his possession an abundance to make him comfortable, and a little to throw into the box of charity, the true way is to cultivate a small farm.

141. I commenced on a farm of twenty-five acres, and performed, with my own hands, all the labor that one man could do conveniently during summer and winter; and can now revert to

that portion of my agricultural career as the most pleasant and profitable part of my whole life up to the present writing, Dec. 1864. It is true that sometimes I was required to labor very hard. But after the few days of hard labor I would feel as cheerful and happy as ever. If I had a field to plow, or sow, I always knew exactly how well or how poorly it was done. If my animals were fed, I knew whether they had enough or only half enough to eat. And so it was with every other operation of the farm. There was *pleasure* in all the labors of the farm. But as soon as I enlarged my farm, and it became necessary to employ men and boys to aid me, almost everything would go like a black bear over a brush fence—*tail* first.

A WORKING FARMER'S PARADISE.

142. If it is a farmer's ruling passion to get money only, money first, money intermediately, and money last; and, if the possession of a great deal more money than he can ever spend advantageously or economically, will afford him more pleasure than a well-cultivated little farm and a comfortable home, with beautiful surroundings, then let him obtain a large farm. But, let him remember, that he must have perplexity or vexation with it.

143. The following thoughts were prepared for the columns of the *Country Gentleman*, which are no less important now than they were then: We hold that fifty acres of good land, or that which can be made good, is enough, unless a man wishes to slave out his whole life in toil—digging till his old back is as crooked as a rainbow—till his muscles crack with the rheumatism, and his joints snap with anchylosis. Some penetrating genius has discovered that man has but one life to live on earth. Then, why toil incessantly for the bread that perisheth? In the sweat of our brow are we to get our bread; but don't let us sweat immoderately for mammon. Enough is all we can use. We know of a snug little farm of 84 acres of cultivated land, and 17 of rocky pasture, which yields a profit much larger than any 150 acres within our knowledge. It upholds a snug little cottage of

eight rooms, a large barn with modern useful improvements, 3 acres of splendid orchard of all valuable fruits, half an acre of excellent garden, an acre and a half more devoted to carrots, turnips, and onions. The fences are all post and rail, bushes and weeds are in eternal exile, and the whole place is exceedingly fair to look upon, and to live on. This man is getting rich by being thorough in everything. His hen-house is perfect, his hens lay, and no droppings are lost. His pig sty is well supplied with muck, and the house slops run into it. After taking the first premium, he puts about six acres of corn into pork, which makes manure —his carrots and turnips he puts into beef, which make more manure. Manure and thorough tillage are the grand secrets of all farming—in New England at least. This man lives well—no pork diet for him—he eats turkeys, eggs, lamb, and the first of his fruits and herds. He dresses well, rides in a carriage, has a good pew in church, and sends his children to the first institutions of learning. His wife isn't worked to death, and has a piano in the parlor. He pays about $50 a year for help, visits his neighbors, and knows how to fish. No rich uncle ever left him any property. He began life by owning about half of his farm, and without any buildings upon it, and $5,000 would not buy his real estate to-day. This farmer is no myth; we know him, and more minute statistics might be given to show that 50 acres is enough—enough, unless a man desires to dig and scrub over a large farm of half tilled acres, and perhaps not be any better off in the end than my easy friend with a small farm.

144. It is a fact that a 200 acre farm might be made equally good; but it is another fact that they seldom are. Thorough tillage in New England cannot extend over a multitude of acres. Fifty acres of rich land (it can be made rich if poor now), with a snug house in a spacious yard, with an abundant fruitage, and everything as perfect as a man can make around it, is a working man's paradise. There is his vine-wreathed arbor, in which to read his papers of a summer Sunday eve and behold the sun sink down through the golden gateway of the west, and while there is everything beautiful and bright around him, in the house

and out of doors, then why is it not all the paradise earth can give? We hold that the man who makes an acre of this earth more beautiful or productive, is doing Heaven service; if he has not over 50 acres, he can make it all shine with fruition and beauty, and never ask discount.

INCAPABILITIES OF FARMERS.

145. It is a great undertaking to attempt to be a skillful, intelligent, and successful farmer; and a farmer's success will depend more on his capabilities, his business capacity, and his management than on everything else; because there is not another occupation among all the trades, professions, arts, sciences, and practices of men which requires the exercise of so much good judgment, good skill, good planning, good execution, and good common sense as farming. We may make a tradesman, a doctor, or lawyer of the veriest piece of stupidity which the country affords, but he never can be made a farmer. A farmer needs *mind.* But how rare is that important quality. Most people have been accustomed to think that if a man or boy was so unaccountably stupid that he never could learn a trade, "he would make a farmer." Never was there a more egregious error. Let us riddle this subject a little, and pour in a few rays of light on the "shady side of American agriculture." Take our country through, and we will not find any other occupation where the management is so decidedly faulty and bad as may be found on the farm. But why is it so? Simply because laborers have not learned the trade which they profess to understand. And the difficulty grows worse and worse every year. Ask your young clerks how much they receive per month for their services; and the answer will be, so much—usually about enough to pay for their board. Clerks are required generally to board themselves. As soon as they have learned the trade—learned to be a good salesman—they will command fair wages, and not till then.

146. Ask those young apprentices what wages they get per month. Why so much—barely enough to pay their board—to say nothing of clothes. When they can perform a good job

in a skillful and workmanlike manner, they expect to receive good wages, and not till then. But how is it with farmers? Why, if a man or boy has two hands and two feet, and is as stupid as an animal with long ears, and if he don't know a sickle from a cradle, or a fanning-mill from a thrashing machine, he must have his *twenty or more dollars per month* of twenty-six days, *and board*, whether he can perform a single operation in the field or barn, in a workmanlike manner or not. Can he harness a span of horses correctly, and hitch them to a plow, with the traces of the proper length, and adjust the plow to run right? Not one in a thousand can do it. But he wants twenty dollars per month and board. Can he sow grain evenly? Never sowed any, but *guesses* he could sow it. Upon trial some of the soil has nothing on it; while in other places the grain is thrown on in streaks so thickly that there will be little but straw. Does he know how to mow and cradle? O, yes. And upon trial he can do it as well as a female can chop wood. Can he go and plow a field, and prepare it for a hoed crop, and plant and cultivate it in a farmer-like manner? Yes, if he has a skillful boss to perform those parts, where the exercise of a little thought or mind is necessary. Give such men good tools to cut cord wood, and to split rails, stakes, or posts, and in more than three-fourths of instances they will cut but little more than enough to pay for their board; and, for want of skill, they will spoil timber enough to pay a skillful laborer for all they will perform. Can they make a good under-drain? The number of those who can do it is as few as the righteous of ancient Nineveh. But twenty dollars per month and board, *cash*, must come from some source. Tell them you want a board or a rail fence built. Can they build it? If they have a skillful foreman to show them *where* and *how* to dig the holes, to set the stakes, and to do every part that requires the exercise of a little thought and skill they can do it. Can they shear sheep? Not a bit of it. Can they prune fruit trees? O, yes. But it will be performed about as the professional fruit-grower from the Emerald Isle pruned a young orchard for his employer. When asked how he succeeded in pruning, he replied, "And I pruned none at all, boss; but I have got them all cut down!"

147. A mechanic in a machine shop, when boring out wheels, or fitting up the bearings of journals, is required to do his work so accurately that any wheel will fit any journal, in a workmanlike manner. And if he bores out a wheel, or turns off a journal the thickness of a thin piece of paper too much, he is required to pay for the iron of which they are made. And this is right. He receives good pay for doing the work well; if he spoils it, he ought to pay for it. But how is it on the farm? We pay an inexperienced, unskillful, and awkward laborer twenty dollars per month and board, to plow our fields in a workmanlike manner. For want of skill the team is stove up and abused; the plowing is performed in the most wretched manner; tools and implements are smashed up as if they were the property of a belligerent enemy. But "twenty dollars per month and board," or a settlement. If there were no more good management and skill exercised in other kinds of business than we uniformly witness in farming, most of our tradesmen and mechanics would become insolvent in less than one short year.

THE REMEDY APPLIED.

148. It is never becoming to find fault with a person concerning his system of management or his conduct, unless we show him immediately a better way, and also how he may improve by availing himself of the advantages which this better way proffers to him. Therefore we will commence at the very *foundation*—the *root* of the matter. In the first place, a man should learn his trade before he thinks of becoming a farmer. (See What a Farmer Should Be, in the Introduction to Vol. I.) He should learn how to work any farm implement, and to wield any tool, in a skillful manner. He should learn to make a practical application of the principles of draft, when hitching teams to any implement, and how to manage any kind of team. Then he will be competent to decide whether a workman works correctly, and drives right or not. But as it now is, not one-half of the proprietors of farms can wield tools, and work implements, and perform certain kinds of labor any better than awkward men. There

fore they are not competent to decide concerning a mans ability to labor. If farmers were skillful at all kinds of labor, and were masters of their business themselves, they would be prepared to test a laborer's ability, and to teach him how to work with skill and with profit to his employer.

149. In the next place, if farmers were only masters of their profession, as all good mechanics and tradesmen are, they would be competent to fix some *standard*—as is done among mechanics —whereby to regulate a laborer's wages according to his ability. This is one of the most important considerations in the whole science of agriculture, in order to be a successful and progressive farmer.

HOW MUCH IS A DAY'S WORK?

150. When Mr. A. employs B, and agrees to pay him so much per day or month, B. agrees, to all intents and purposes, whether the fact is or is not mentioned by either of the parties, to return to A. an *equivalent* in labor performed for the money received. In other words, B. virtually *affirms* that he is *competent* and *willing* to return a fair equivalent in services for the stipulated wages. This is equitable, fair, just, and right. Both parties agree as touching this point. Now, then, suppose for example that A. manages to defraud B. out of one-third or more of his wages, after he has performed faithful service? Why, you exclaim, "That's down right knavery!" All right. Now, suppose B. don't know how to put his tools in order, nor how to use them after they have been put in order, and, consequently, is not able to perform half a day's work in a day. Or, suppose he is indolent, always tardy, always quitting work before the proper time, and never appears to care whether he performs a good day's work or not. "Well," you say, "we must expect such actions; I don't know as there is any remedy for it."

151. There *is* a remedy, and a very effectual one too, for such—knavery! Yes, that's the right word—*down right knavery!* It is as great a moral evil for a man to *agree* to do right, and to be honest and faithful, and then not to do it, and thus cheat his employer, as it is for his employer to cheat him. Thousands upon

thousands of laborers cherish no other idea, concerning an equivalent for their wages, than "to keep a going or keep a doing." "I did'nt agree to do so much work," says a laborer, "I am only required to keep a going!" Illustrious stupidity. But farmers alone are to blame for such erroneous notions concerning labor; and if they were masters of their employment, laborers would soon learn that they would receive pay according to the labor performed, and not according to the time that they squander away in doing little or nothing.

152. But, how much is a day's work? A day's work is the amount of labor that a man of ordinary strength can perform, who can handle his tools skillfully, and labors faithfully during working hours. This is a day's work, at any kind of labor. In mowing grass, for example, if it is not down, and not very heavy, a man can cut from two to three acres in a day, if he knows how to put his scythe in order. The writer could do it, and did do it when he was only fifteen years old, and is able to do it with ease at the present writing. But if grass were lodged, more or less, a man might labor hard and be able to cut not more than half an acre. Thus it is with almost every kind of farm labor. And we have made these suggestions that proprietors of farms may investigate this subject, and thus obtain a more correct understanding of what constitutes a day's work at any kind of labor. Every farmer ought to be so familiar with every branch of manual labor as to be able to decide at a glance whether a man has performed a day's work or not. And if every farmer were master of his business, could put his tools and implements in good order, and could handle them with dexterity and skill, indolent and disinterested laborers would soon learn that they could not impose on farmers as they now do. And the result would be, farmers would get their work done much cheaper, better, more promptly, and with far less anxiety and perplexity than they now meet with. I have known farmers who did not know how much a day's work is, to censure laborers when they had worked faithfully, and to commend them when they had labored very unfaithfully. These considerations suggest to us why it costs some farmers twice as

much as it does their neighbors to cultivate the same number of acres of land on which the same crop is raised.

SUCCESS WILL DEPEND ON MANAGEMENT.

153. After reading all the best books; after obtaining the best tools and farm implements; and after consulting the best authorities for carrying on farming operations, success will depend on a man's *general management.* It is the *management*—management first, management last, as well as the *best* of management intermediately, and collaterally—that crowns a farmer's labors with success. This will involve *everything* when taken in one harmonious combination—the management of the soil and the management of stock; the management of crops and the management of manure; the management in the field, and the management within doors; the management in the kitchen, and the management with laborers and with hired girls; and last—but most difficult and important of all—will be the *right* management of the loving wife and the darling babies.

154. If a farmer does not possess the faculty of being a good manager in every department of his business, it will be the height of folly to cherish the idea that he is going to be successful as a farmer. In order to be able to manage a farm as it should be, a farmer needs more experience—more discipline—more practice—more of an investigating spirit—and more rigid drilling in his business than a general does in military tactics, to be able to manage an army of soldiers. Let me reiterate this thought; and let every young farmer, as well as old one——write down this maxim in large letters, and place it where he can read it when his hands are laboring—*your success will depend on your management.* In order to give practical illustration of some of our ideas on good management, we copy a short communication which was penned several years ago for the *Country Gentleman:*

GOING TO THE FIELD TO WORK.

"A string in your button-hole, pin on your sleeve,
A knife in your pocket, to whittle and cleave,
A wrench and a hatchet, a nail and a bit,
And a little acumen to make them all fit."

EDWARDS.

155. One of the standing and oft-repeated maxims of my father to his sons and those in his employ was—"Never go away from home, even on a pleasant day, without an overcoat; and never go into the woods with a team without an axe." This precept was well endorsed by his inflexible example in both respects; and many times, that apparently needless overcoat, which sun and skies and the ever-changing, but now pleasant weather, assured us would be nothing but a burden to us, has proved to be a source of great comfort; and that faithful axe, which was carried to the woods and back again, many times without needing it, often saved an hour's work. Turning these suggestions to a good account, I have many times when hauling timber or wood, nearly a mile from the workshop, found that a bit of twine, or a nail in my pocket, has enabled me to move along with my load, making only a few minutes' delay. Also, when the team goes to plowing, for instance, in a distant field, one of my rules is to hitch to the stone boat and take along an extra plow point, axe, wrench, hammer, a few nails, a billet of tough wood, a piece of old boot leg, a piece of twine and the *water jug;* for I find that, as a general thing, my hands always want *a drink* soon after they reach a distant field. Therefore I have them "call the roll," when about starting for the fields, so that half an hour or more of precious weather in seed time may not be lost. I do not advocate, or practice, tying up, and toggling harnesses and tools and implements, except *pro tem.* No man is able to tell whether his tools and implements will or will not give out, when we would not have a team obliged to stand idle an hour for one dollar. Suppose the plow point should strike a fast stone and break, and another is not at hand. That hour, or half day during which the team was idle, waiting for another plow point,

may bring a very important job within half a day of being ready for a heavy rain. Farming operations are often at the mercy of storms; and I have often heard farmers say with deep regret, "Could I have had two hours, or half a day more, before this heavy rain came on, that field of grain might have been harrowed in, when it would have been worth many dollars more than it will be now." I remember of meeting with a teamster, with a load of lumber—several miles from home—who had just broken an iron loop in one of the hames. He was about unhitching to go home, as he had nothing in the shape of a string to tie up his broken hames. Recollecting how I got out of a snow drift once with a load, by using a few of the long hairs of Doll's tail in the place of a broken cockeye of the trace, a few of those strong hairs soon repaired his broken hame, and thus saved him a half day in returning after his load.

REQUISITES OF A SUCCESSFUL FARMER SUMMED UP.

156. It requires a very smart man for a successful farmer. With all the money and agricultural books, and farm implements, and good farms in the world, it will be impossible to make a successful farmer of a numbskull. He may be wrought into a minister—for the Almighty often chooses "the foolish things of this world to confound the wise,"—but were he to live coeval with Methuselah, he would be obliged to emigrate to a new farm every thirty years, just as multitudes of men—not farmers—now do, by going to a new country to avoid starvation.

157. The first crowning requisite of a successful farmer is a correct understanding of agriculture in all its branches. This involves almost everything, that we can mention, which is connected with the subject. He requires knowledge to make a selection of the best animals, that are best adapted to the soil and its productions; cultivating a rotation of crops which are best adapted to the soil; maintaining the fertility of the soil, by under-draining that which is excessively wet; and thorough pulverization and fertilization with materials which the farm affords; and laying all the plans for out-door and in-door's labor in such a

manner that everything will be attended to in good time, and without one interfering with the other. "Then," says J. J. THOMAS in *Annual Register*, "the business, instead of being repulsive as it so frequently is to many of our young men, would be attended with real enjoyment and pleasure. But success must not be expected without industry and diligence. Labor must be the motto, and work the watchword."

158. My own practice always was *to keep to work* every day. When I could earn but twenty-five cents per day—work. When fifty—work. When one dollar, or five dollars, or eight dollars, I always kept working at improvements on the farm, or at tools and implements in the shop. But at the most busy season of the year, I always found time every day to do something towards keeping the *mind* active and thoughts clear. All the hard work that I ever performed, and I know I have "done a heap of it," never injured me. But bad habits have. And it is the bad habits, not the labor on a farm, that tires out and breaks down so many men. Therefore *good habits*, with a knowledge of one's business, will constitute the crowning concomitant among the first and the last requisites of a successful farmer.

WATCHING FOR IMPROVEMENTS.

159. My own practice always has been to take practical observations with reference to various improvements on my farm, not only with reference to draining and improvement of soil, but in adapting different crops to a given soil; and the very best time to do this I always found to be when the soil was being plowed, and when the crops were being harvested. For example, when plowing, sometimes there would be a wet, springy place in a certain part of the field that required underdraining. Now, by observing where the water came from when the soil was being plowed, I could often determine where a drain could be made that would save a great many dollars' worth of drain, if it were made without knowing where the water came from that rendered a large spot so wet. Stakes would then be set where the drain should be made. Then, when the time arrived for making the

drain, I always knew exactly where to make it, where it would drain the soil most. Another way in which I was accustomed to watch for improvements was, both when plowing and harvesting, to notice particularly the poor as well as the rich spots, and drive down stakes at their borders. Then I always knew exactly where to apply fertilizing material, and where more was needed. I have my mind on portions of certain fields to which I never allowed a handful of fertilizing material to be applied during the sixteen years that it was cultivated, from which a crop was removed every year; and while other portions of the field were very highly manured, and extra pains taken to make them yield a crop about equal to the unmanured portions, still these unmanured parts would yield more than double the amount that would grow where manure was applied. In addition to the foregoing suggestions, every farmer should keep a vigilant eye on growing crops at all times, and watch the effects of underdraining, deep plowing, shallow plowing, thick and thin seeding, as well as everything else that tends to reflect light on his occupation, and to render his labor lighter, his forces more effective, his crops heavier, and his farm more valuable.

PRACTICAL MAXIMS FOR YOUNG FARMERS.

160. Many farmers do not know when they are really doing well; and many times, when they have made an excellent beginning, and are in a fair way to make a good mark in life, and to distinguish themselves as excellent farmers, will "sell out." If a man is doing well, he ought to know it. And if he is *not* doing well, he should satisfy himself that he can better his condition by selling his farm. Stick to your farm; and if you have a good location, do not sell out expecting to better it because you are offered a good price. If your neighbors can make farming pay on your farm, resolve that you can do it as well as they can. The *Country Gentleman* says: "Do not change farms often; for by so doing you can carry out no definite system of improvement. An excellent farmer may spend several years on a farm before he will be able to determine what system of farm management he had

better adopt, and which will be best adapted to his soil. Do not begin to improve till you have a general plan of what you wish to do; to do so would be like commencing to get out timbers for a house before you know its length and breadth. Unless your crops are good ones, sow less and plow better. Lay out a system of improvements for your farm and buildings; and, as your means permit, carry these plans out. Do not enter upon speculation with other people's money, or your own, unless you see clearly that you will make profits; and even then do not do it to the neglect of your farming. Do not mortgage your farm for money to buy goods; very few men can enter the mercantile business without training for it, and not become bankrupt. Do not buy fancy stock and pay fabulous prices, on the spur of the moment, or without knowing why you want it, and how you are to make the investment profitable. Do not keep poor stock when you can keep good at the same expense, and with four times the profit. Do not change your kind of farming, because what you raise this year is low-priced, for that which is high. Ten chances to one your crop will be up next year, and that which is up now will then be down. Do not try to grow those crops for which your farm is not well adapted. Resolve that your farm shall be a profitable one, if industry and good management will make it so. Invest your surplus earnings in making such improvements as will add to the profit, appearance, and convenience of your farm. When you make experiments, see that you keep within the laws of nature. These are the farmer's helps. Make such experiments as appear to be reasonable, no matter what your neighbors say. Make yourself thoroughly acquainted with the principles of agriculture, and be guided by them. Do not keep more stock on your farm than you have plenty of pasture for. Never enlarge your farm when half of it is not half cultivated. If you own more land than you can till well, are in debt, or need funds to make necessary improvements, sell part of your farm, and use the money to pay your debts, and make your improvements. Never borrow money to build a showy house, when a less pretentious one would answer better; and never lend money when you have poorly tilled land to improve.

161. This is a great error with American farmers—to build such spacious dwelling houses, and very small outbuildings. There is but little danger that a farmer will erect outbuildings too capacious. But the common practice, which prevails all over our country, of building so much house room, that cannot be used to any kind of advantage, and launching into debt for it, as thousands of young farmers are accustomed to do, is a practice that cannot be denounced in too strong terms. Erect a plain, cheap, and comfortable dwelling house *first;* and use up all money that is accumulated from year to year in carrying out improvements in the field, instead of putting it on interest. Solomon says (Prov. xxiv. 27.): "Prepare thy work without, and make it fit for thyself in the field, and afterwards build thy house." Remember that a thousand dollars invested in large parlors and costly furniture will increase the amount of a farmer's taxes a great many dollars; whereas had that sum been invested in erecting necessary outbuildings, and in improving the live stock of the farm, and in improving the fertility of the soil, which would render the farm really more valuable, his taxes would be comparatively less. Let me reiterate this caution, not to erect costly dwelling houses until the farm has been brought to such a degree of fertility as will be in keeping with an expensive dwelling house. (See Vol. I., p. 24.)

THE PRACTICAL ADVANTAGES OF MOMENTUM.

162. Our apology for introducing momentum is, that former writers have not discussed its practical advantages to farmers. Momentum is the force of motion. Philosophy teaches us that if two bullets, for example, one weighing one pound, and the other ten pounds, were to strike each other squarely when the one pound bullet was moving ten times faster than the large one, they would both be brought to a dead stand still, and would drop to the ground. The theory on this point is correct; but it would fail in practice on account of the elasticity and compressibility of matter. The large bullet would

be indented a little, while the small one would be very much flattened, and carried with the large bullet in its course.

163. An excellent illustration in practice is furnished in driving slim nails into the tough hoofs of animals. With a very light hammer, by which the momentum is obtained by a quick and swift motion, the nails are driven in with no difficulty, when not a single one could be driven with a heavy hammer, whose momentum would be exactly equal to the momentum of the small hammer. And this holds good when driving nails into hard wood, where they are liable to double up after they have entered but a short distance. With a light hammer they can be driven; but with a heavy one they will double up when the momentum of both hammers is, in theory, the same. When a man drives a stake into the ground on account of the elasticity and compressibility of matter, he cannot do it with a light hammer, because the wood will batter up so badly. Therefore, he takes a heavy hammer; and by means of the momentum of a heavy body moving slowly, he performs what he could not do with a light body moving rapidly. When a sleigh or wagon is frozen fast to the ground, instead of taking a hammer or some light body to knock it loose with a quick blow, which would damage some portion of it, we take a piece of timber as large as we can handle, and thus, by the momentum of a heavy body moving slowly, we accomplish, without injuring anything, that which could not be done with a light body when wielded quickly.

THE PROPER MECHANICAL CONSTRUCTION OF TOOLS AND IMPLEMENTS.

164. There is no more important principle in agricultural dynamics than a correct understanding of the most proper weight for every tool and implement. Mechanics, who make the tools, as well as the farmers who use them, should understand correctly the difference between accomplishing a certain result by means of muscular force only, or chiefly by the momentum of a tool. In turning a fanning mill, for example, the force required is entirely muscular—the power of the arms. We cannot avail ourselves of

any aid by using a balance wheel on the journal of the fans. But a balance wheel of thirty or forty pounds on the journal with the *crank* would enable a man to turn it with less fatigue to his arms. This is on the same principle that a man can turn a journal having a wheel or a grindstone on it that weighs one hundred pounds, when no one is grinding, with much less fatigue than he can turn nothing but the journal, because the momentum of the wheel will aid the muscles of the arm in raising the crank at every revolution. (Read about A Grindstone—How to Select, How to Hang It, Vol. I. p. 374.) But the smaller and lighter a grindstone is the less muscular force will be required to turn it while one is grinding, unless he turns it with a treadle.

165. We attach balance wheels to straw cutters, corn shellers, root cutters and saws, for the purpose of accumulating the force, or of doing by the momentum of the wheel what could not be done by muscular force alone. But the error that I desire to point out here is, in making balance wheels too heavy. There is a great efficiency in a balance wheel when it is not too heavy in proportion to the force employed to turn it at a given velocity. If, for example, a wheel weighing one hundred pounds be attached to a circular saw driven by two horses at the rate of ten or twelve hundred revolutions per minute, the momentum of that wheel, in connection with the muscular force of the horses, will operate very effectively in sawing wood. But as the wheel is much lighter than this, it will not accumulate so much of the force of the horses. And if it be increased in weight, the increased weight will absorb too large a portion of the muscular force to keep it in motion.

166. Balance wheels are put on hand corn-shellers many times twice as heavy as they should be, because they absorb much of the effective muscular force of the person who turns them. When a man cannot tell when an ear is being shelled, the wheel is too heavy. A wheel may be heavy enough to absorb all the muscular force to put a machine in motion, so that it will do little or no work at all. A cylinder of a thrashing machine is a modification of a balance wheel. The momentum of a cylinder and spikes

does the thrashing. Now, if a heavy cylinder be used with a two horse machine, all of the effective muscular force of the horses will be absorbed in driving the cylinder fast enough to thrash grain clean. When I was a young man I made a turning lathe to be driven by hand or a treadle. The wooden driving wheel was about five feet in diameter, and would weigh about one hundred and thirty pounds. I could drive it with one foot, and turn at the same time with ease. Many people told me that my driving wheel was not large enough nor heavy enough, and that a larger and heavier wheel would run as easy again as that light one. So I procured another wheel, seven feet in diameter, that would weigh over two hundred pounds, and hung it where the light one was. But, to my great surprise, it required all my leg-power to simply get up motion high enough for turning, and I could do nothing at all with it. It was too heavy for the muscular force employed to turn it.

THE CORRECT WEIGHT OF TOOLS AND IMPLEMENTS.

167. When labor is performed by means of muscular strength only, the lighter tools and implements can be made with consistent strength the better they will be. Read about the Shovel and Spade, Vol. I. p. 238. As nothing can be effected by the momentum of the shovel and spade, the lighter they are the better they will be, if sufficiently strong. So it is with pitch forks, hand rakes, grain sickles, corn cutters, and many other tools which are worked with muscular force only. These should always be made as light as possible, with consistent strength. The grass scythe and snath, the grain cradle and the broad hoe, are tools whose efficiency depends almost entirely on the muscular force that wields them. The momentum of a broad hoe does not amount to much. Therefore the lighter it is the less a man will feel fatigued in using it. The efficiency of a grain cradle will depend, in a very limited degree, on its momentum. But they are made so heavy almost always, that more is lost by unnecessary fatigue in handling them than is gained by the momentum of a heavy cradle. Grass scythes are worked almost entirely by

muscular force. Therefore let them be as light in every part as is possible with the strength required. See the article on How to Grind, Hang, and Use Grass Scythes and Cradle Scythes, fully explained and illustrated on p. 382 of Vol. I.; also read the chapter on Edge Tools, p. 369, Vol. I. When any tool is only one pound too heavy to be equal to the muscular force that wields it, that unnecessary pound will operate against the efficiency of it. Every farmer should make himself familiar with the strength of materials in constructing farm implements, and always aim to have them made as light as will subserve the purpose for which they are designed.

168. Wheel vehicles, lumber wagons and carts, are almost always made one, two, or three hundred pounds heavier than is necessary for the strength required. This unnecessary weight is a nuisance, because it absorbs so much of the effective muscular force of the team. This is particularly true concerning ox carts and ox sleds. They are often heavy enough for a team without any load on them. Plows, horse hoes, and wheel cultivators have been very greatly improved, as it respects their correct weight, and still there can be quite as much improvement made in many of them as has already been made. The momentum of a plow does not amount to anything towards drawing it—consequently the tens of unnecessary pounds of iron and wood that are worked into them, in places where it only increases the weight, thus absorbs the effective force of the team. (See Light and Heavy Plows in the chapter on Plowing.) We trust that these random suggestions will induce farmers to think and to investigate the principles of mechanics and of agricultural dynamics, and thus have their tools and implements made of the most correct weight, as well as form, to secure the greatest effective force when they are in operation.

AN AGRICULTURAL SERMON.

169. "If, therefore, ye have not been faithful in the unrighteous mammon, who will commit to you the true riches?" Luke xvi. 11. Mammon means worldly possessions, such as real

estate, farms and their appendages, and the live stock of a farm. The true riches means the pleasures, the happiness, and the enduring enjoyment which are reserved for those who love and serve the Lord in this world. Thus the apostle says: "Eye hath not seen, nor ear heard, neither have entered into the heart of man the things—the true riches—which God has prepared for them that love him." 1 Cor. ii. 9. The true riches may mean eternal life; and the expression stands in contra distinction to mammon of unrighteousness, or the things which constitute worldly possessions.

170. The argument made use of in the text by the Son of God is, that if a man has been unfaithful in his business, or in the management of his earthly affairs, he would be rejected in the next world from holding any position; because he had been unfaithful in managing the affairs of others—which is emphatically true of a farmer. He is only a trustee or a steward, or agent to manage a farm for a few years. It is not his. It is only entrusted to him to cultivate—to improve by art—to embellish; and to make it a source of comfort to himself while he remains trustee or manager of it; and then to leave every part of it as good as he found it. Hence the words of the text: "If you have not been faithful in managing your worldly possessions, or unrighteous mammon, who will commit to you the true riches?" Or, as the Great Superintendent of agriculture will not commit to you any heavenly possessions, because you have been so unfaithful in the management of your farming operations, who do you expect will do it? If you forfeit all claim to any inheritance by your unfaithfulness in little affairs, in the management of a farm, for example, when you are done with the unrighteous mammon, and go up to the throne of the great Agriculturist, with the expectation of receiving anything that he has promised to the faithful in this world, you will meet with a sad disappointment; because the Almighty will not commit to unfaithful men the true riches of his dominion. And if he who is the sole possessor and king refuses to commit anything to your trust, "who," says Jesus, "*will* do it?" This was his affectionate way of telling his dis-

ciples by asking them a question, that if they were unfaithful in the management of their earthly affairs or farms, God would bequeath the inheritance that was designed for them to others who had been faithful in little things. We see from this subject

THE DUTY OF A FARMER TO KEEP HIS SOIL GOOD.

171. A farmer is a trustee, or a steward. His great Employer has committed a charge to him, and said: "Occupy till I remove you. Raise whatever crops you choose; but keep the soil in as good a state of fertility as it was when you received it. The soil is to support those who will come after you. It is the worst kind of robbery to take crop after crop of grain off a farm, and do nothing towards repairing the waste. He who recklessly adopts a bad system of husbandry not only wrongs himself but is guilty of great injustice to his successsors. The Creator works by means; and he will not restore impoverished soils by a miracle. If a farmer, by bad husbandry, injures the fertility of his soil, he, and those who come after him, must suffer the damage resulting from his abuse of the resources of the farm. It is therefore the solemn duty of every man to try to keep his soil in a good state of fertility, by means of the manurial resources which it affords. If he does as well as every farmer *may* do, the day will soon dawn when our grass fields will yield two spears where only one grows now; and all our crops of cereal grain will be increased at least two-fold. Every farmer can do this in a few years by simply commencing a renovating system; by under draining, manuring, and growing crops in rotation. Let young farmers resolve to leave their soil in a better state of fertility than they received it. Then they will have the satisfaction of knowing that they have been "faithful in the unrighteous mammon."

HOW TO RENT A FARM.

172. The correct way to arrive at a fair price for both parties is the following: add the value of the cultivated land and buildings to the value of the stock and tools. If a renter have no benefit of wood land, the growth of timber and increasing

value of the land will be an equivalent for the interest on it. Now, if a renter agrees to pay to the proprietor annually, six, seven, eight or more per cent on the aggregate value of stock, implements and farm, and keep the soil in a good state of fertility, and make certain improvements every year, the proprietor will receive a better compensation than the renter. A renter could not make a decent profit on many farms were he to hire them at six per cent; while on others, he could afford to pay twelve per cent. The productiveness of the soil must be taken into account. Then the per centage must be lessened in proportion as a renter makes improvements that will increase the value of the farm. If he rents a farm for a term of years, and certain improvements will benefit him as well as the proprietor, each one should share in the expense.

173. A written contract between the parties should require the renter to adopt a rotation of crops adapted to the soil; to allow nothing to be carried off the farm that would make manure; to allow no manure to be wasted by remaining in heaps from year to year; to keep the stock good; to keep all tools, implements and buildings in good repair, making allowance for their natural wear; and not to damage fruit or ornamental trees in any way. The prices at which everything is valued in different localities renders it quite inconsistent to do anything farther than simply make suggestions on important points, at which a fair contract for both parties may be framed. When a farm is worked on shares, the proprietor should so frame the contract, that hay, straw, cornstalks and other coarse material shall not be carried off the soil; and he who works it should make and apply a given amount of manure annually. If foreign fertilizers are applied, the proprietor ought to sustain a small portion of the expense, if he receives a share of the grain. The contract should not allow a man to plow up the entire farm at one time, so that there will be no grass the next season, either for pasture or meadow.

DETAILS OF FARMING OPERATIONS FOR THE SEASON.

174. The first crop to be put in, in the spring, will be spring

wheat or barley, then oats may be sowed. As soon as the oats have been put in, it will be time to commence preparations for a crop of Indian corn. After the Indian corn is planted, turnips should be planted. After this plow the buckwheat ground, or plant a crop of beans, or both.

175. At this period, there will probably be a week or two in which to shear sheep, make fences and drains, &c. Then, if proper calculations have been made the year previous, there will be a field of early grass to cut, to make into hay. Then, by the time the hay is made, the corn will need to be cultivated. Then, the turnips will need attention. Then, buckwheat must be sowed. After these operations, late grass may be cut. Then, go through the corn again. By this time the golden grain will be ready for the reaper. After harvest, preparations must be made for a crop of winter wheat, by plowing, and making compost. Lowery weather and rainy days should be spent in making improvements around the out-buildings; and weeds must all be cut or pulled up among the Indian corn, turnips and beans. The care of stock will also come in through the entire season among the incidentals.

176. After winter wheat has been put in, there will be a week or two of comparative leisure, when stones may be hauled, ditches made, fences repaired, and potatoes dug. If Indian corn and buckwheat are still green and growing, fall plowing may be done. Then, Indian corn must be cut up. After this buckwheat will be ready to be cut and secured. Then, apples must be gathered; Indian corn must be husked, the stalks must be secured; and roots pulled; and fall plowing finished.

177. The foregoing details are calculated for only a certain kind of soil. The intelligent farmer will understand that these are given only as an illustration of the details of a single instance; and they are designed to aid him in laying out his field labors in such manner as to have profitable labors going on during the entire growing season, so far as may be practicable. We may illustrate this subject still further by alluding to the details of the numerous

INJUDICIOUS SYSTEMS OF MANAGEMENT.

178. That are practised to a very great extent all over the country. On some farms, nothing but oats and summer fallow, and a crop of wheat follow each other, from year to year. Such a system of management makes a great amount of labor at seed time as well as at harvest. The labors of men and teams are not distributed throughout the season. Consequently, additional teams and laborers must be secured at a very costly rate, in order to accomplish the work in the proper time. And if crops are not put in or not harvested in good time, the proprietor must sustain more or less loss. But it suits many farmers to employ a host of teams and hands at one time, so as to have the work all done up; and then have nothing to do for many long weeks together.

FITTING UP MACHINERY.

> "The ringing of the anvil, the grating of the drill,
> The clattering of the turning lathe, the whirring of the mill,
> The puffing of the engine, the driving of the awl,
> These busy sounds of workshops I love, I love them all.
>
> MRS. F. D. GAGE.

179. Farmers must, of necessity, use a large number of machines and implements; and as many new ones are introduced, which are manufactured by men who are not and never can be worthy of the title—a good machinist—my design here is to lay down a few plain and practical directions on fitting up machinery, not so much for the purpose of aiding a farmer in doing it *himself* as for enabling him to understand how it *should* be done by a machinist, and when a job is performed in a workmanlike manner. (See Introduction to Vol. I.)

180. The superior excellence of almost any machine or implement consists in the most symmetrical proportion of its parts—its simplicity as opposed to its complexity, and the workmanlike manner in which the various parts are fitted up. One of the most prominent features of *perfection* in fitting up machinery is *the stillness with which it runs*. Some kinds of machinery will [illegible]

up most perfectly; but, for the most part, the incessant clatter, and rattle and jar, and tumbling of machinery—sometimes noisy as "the seven thunders"—can be traced to imperfect construction or fitting up. There are a host of very important considerations to be taken into account, in constructing any kind of machinery, in order to make every part just as it should be. Every redundant pound of wood or iron should be rejected or cut away; and every part which is subjected to more or less strain should be made of a form which will be strongest when made of the smallest amount of materials; and those parts which are liable to wear, should be of such form and *condition* as will run together with the smallest amount of friction. The force employed for working machinery on the farm is quite limited; therefore every redundant pound of materials in a machine, and every imperfection in fitting up the working parts of it, detract in the proportion of their magnitude from the *efficiency* when in operation.

181. Every machine should be made of as few parts as will be most *convenient* and *practicable*. The larger the number of wheels and journals in any machine, the more friction there will be, and the more liable it will be to get out of order. Consequently, the greater the amount of friction, the more of the effective force which drives it will be absorbed in simply putting the machine in operation. Hundreds of machines and implements are constructed so improperly and unwieldy, that it is no uncommon thing to have more force absorbed in giving an effective velocity to them, *without performing any work*, than would be required to perform a good business, *besides* putting them in motion, providing they were properly constructed and fitted up.

JOURNALS OF MACHINES.

182. Journals are the spindles or shafts which sustain the wheels and pullies and other parts which revolve. The bearings of journals are those parts which rest in cavities or holes called boxes. Journals are also called *arbors*, and sometimes improperly called gudgeons. But *arbors* are only those parts of a

journal that revolve in the boxes. Gudgeons are iron pins or bearings inserted in the *ends* of wooden shafts or cylinders, and do not, like journals, extend from end to end of a shaft. The bearings of all machinery, when saving power is any object, should be made as small as possible with the consistent strength. The smaller in diameter the bearings are, the less force will be absorbed when putting machinery in motion. The bearings of the greater part of all agricultural machinery are made too unprofitably large. The size of the bearings exert a much greater influence on the ease with which machinery may be worked than most machinists are accustomed to compute. A journal four feet long, sustaining wheels or pullies having a high motion, will run more steadily and smoother than if it were only a foot long. If the bearings of a journal of a cylinder to a thrashing machine are about seven eighths of an inch in diameter—which is sufficiently large for small thrashers—less power will be absorbed to make it revolve at a given velocity than if the bearings were an inch and a half in diameter. When almost all the strain is applied to one end of a journal when it is made to revolve, and every little stress comes on the bearing at the other end, the last one referred to may be made very much smaller than the one near the other end; and it is always well, and usually *best*, to make the end small under such circumstances.

FITTING UP THE BEARINGS OF JOURNALS.

183. This is a piece of work of which most farmers have no practical knowledge; and the majority of them do not even understand the *importance* of having them properly fitted. When the bearings of a journal are hammered as true as is practicable, and *filed* smooth as they can be, they are utterly unfit for any part of a machine in which saving of power or diminishing of friction is any object. The most skillful machinist in the world cannot fit up the bearings of a journal with hammers and files alone in a proper manner, any more than he could cut out a neat bedstead without a turning lathe; because such things cannot be made perfectly round and true without being held in a lathe, while

they are being fitted. If the bearings are not entirely true and smooth, the friction will be great, and the bearings, or their boxes, or both, will heat, even when well oiled; and will very soon be so badly cut out or worn away, that a break-down will be the sure result.

184. In order to fit up the bearings properly, depressions are made with a pointed punch in the ends of the journal, *exactly in the centre*, when it is put in the lathe, and made to revolve slowly, while the bearings are turned as true and smooth as they can be by cutting a shaving so small, the last time going over it, that it is hardly perceptible to the naked eye. After they have been turned they are sometimes filed a little as they revolve, and then polished with emery and oil so brightly that the workman can see the color of his eyes in them as in a looking glass. A kind of clamp, made of soft wood, is used to squeeze the bearings, which holds the emery and oil, while polishing them. Sometimes it is done by holding a soft-wood stick on them as the journal revolves rapidly. The emery is held by being imbedded in the stick while the stick is pressed on the bearings. In fitting up a journal of wrought iron, *one side* of the bar is frequently so hard that it will take the edge off the turning chisel in an instant For this reason a bearing often wears on one side—the soft side—so that it is of an oval form. This is particularly the case when the boxes are *harder* than the bearings. After the bearings have been polished they are sometimes *case hardened*, by making a thin portion of the surface of the bearings entirely around them as hard as a file.

185. Journals are sometimes made of steel, which are always much superior to common wrought iron, especially for small ones. As steel will admit of a finer polish than iron, machinery may be made to run much easier on steel bearings than on iron ones.

186. Journals are often made of *cast iron*, and when there is not much strain or jerk on them they are quite as good, and sometimes better than wrought iron. As the surface of even *soft* cast iron is covered with a very hard, rough scale when it cools,

from the furnace, the bearings of the pattern should always be made an eighth of an inch or more *larger* than they are to be when fitted up, in order to make suitable allowance for turning off the hard scale.

187. *Cast iron gudgeons* are often fitted to their shafts without being turned either before or after they are put in. The true way to fit up a shaft of any kind, with gudgeons in the end, is to put in the gudgeons *first*, before either are turned, and then put them in a lathe and turn the bearings and shaft, if desirable, as if the whole were one journal. The most skillful machinist in the world cannot put the gudgeons into a shaft *after* they have been turned, and have them run as true and easy as they would if they were turned *after* they were put in. The least perceptible variation from trueness in the bearings will cause a journal to run harder than it should if it were true, and it will soon begin to wear on one side, or to cut the box.

188. I have in mind several men who did not appreciate the importance of having the bearings of shafts and journals neatly fitted up in a lathe, who failed entirely in accomplishing their purpose from this single neglect. I well remember that when a small lad my father employed a mechanic to build a horse power for a cider mill. The gudgeons were cast iron, and were put in without being turned. I know it was very hard work for two horses to work it; but had the bearing been properly fitted up in a lathe, one horse would have been able to do more with it than two were accustomed to perform. Most men appear to think that if a gudgeon is cast after a round and smooth pattern, it will be just as well to *file* them a little without turning them. But it is a very great error to think so; and, more than this, the expense for files to file off the hard scale on cast iron would be *greater* than the expense of turning, and the job would not be half done, as it should be. When fitting large gudgeons into a water-wheel shaft, or fitting a crank into the shaft of a new mill, they would run enough better to pay the expense of carrying the shaft ten miles to have the bearings turned *after* the gudgeons have been put in. The bearings are much better, except for very

small ones, when *four* inches long, than when only two inches long.

FITTING A SMALL JOURNAL TO A LARGE HOLE.

189. It is a very common thing that a wheel of some kind, having a hole already bored out in the centre of it, would fit a certain journal if the hole in it were not *larger* than the journal. When a journal is not more than a hundredth part of an inch smaller than the hole, if wrought iron, it may be hacked a little with a cold chisel all round it, and then turned off true. Sometimes a piece of tin or sheet iron put round the journal will make a good fit. When there is a half inch or more difference between them, let a blacksmith put two red hot rings on the journal—*shrinking* them on—when they may be turned off to fit the wheel as neatly as if it were a large journal. Twenty-five cents expended in this way will sometimes save a number of dollars.

FITTING UP BOXES FOR THE BEARINGS.

190. This operation has almost as much influence in rendering machinery perfect as fitting up the *bearings* of the journals in a neat manner. Iron boxes, except when a shaft revolves slowly, are not half as good as some other metal. Indeed, no machinery will run as easy and as long without heating and wearing, when the boxes are iron, as it will if they are wood, brass, copper, lead, or some other metal. When any part of machinery has a reciprocating motion, like the connecting rod or pitman of mowers or reapers, where there is a high motion, and as much jerking and thrusting as there is in that part of a reaper, the cross heads at the end of the pitman ought to be made of one large piece of brass, not less than two inches wide, instead of a little, thin, narrow eye of iron, fitted to the crank or wrist-pin of the cam, which will heat and wear out in one season. This is a very great defect in nearly all the mowers and reapers now manufactured. When boxes are made of iron they ought always to be bored out true and smooth in a lathe. Some times iron boxes are bored out just enough larger than the bearing to

admit of being lined or bushed with strips of sheet iron. Sheet copper is often made use of for bushing wooden boxes. Machinery will run much easier with *copper* boxes than when they are iron; and when the timber of a machine is hard wood, it is sometimes better to bore out or gouge out a groove in the wood, and fit a piece of sheet copper in it, and hammer the ends of it down, and nail them to the wood.

191. Another manner of fitting up boxes is to cut out the wood a half inch or so larger than the bearing, and fasten the journal, after it has been finished, exactly in the place where it is to be when the machine is in motion, and then pour in melted lead or zinc, or babbet metal, so that it will form a half box for the bearings. Previous to pouring in the melted metal the polished bearing should be oiled. This is a very cheap way of making good boxes; and a large portion of machinery is fitted up in this way. When boxes are bored out and bolted to the wood work of a machine, it sometimes requires all the skill of a good machinist to get the boxes just right. But when the polished bearings are held in their places, and melted metal poured *around them, they will be correct without fail.* When lead or zinc is used for boxes, the bearings must be neatly polished and must be kept well oiled. Machinery with lead boxes will run as easy as when they are made of any other metal; and if the machinery is not heavy, nor subjected to powerful strains and thrusts, it will wear well.

192. I have a grindstone, saw journal, and some other pieces of machinery, which have run in lead boxes for twelve years, and are as good as when they were new. Zinc and babbet metal being much harder than lead, are preferable to it, unless machinery is always to be in the care of a man who will *always* keep the bearings well oiled.

193. When circular saws, and some other kinds of machinery, are run by water or steam all day, the bearings run in large boxes, which have a recess in the bottom part large enough to contain a quart of oil, which is supplied and applied to the bearings as fast as it wears away, by means of a strip of lamp

keep it in its place, even after they had rolled a large bowlder, weighing some three or four hundred pounds, on the top of it. A few spikes had been broken off one side; and no one present knew anything about balancing machinery, and had probably never heard of such a thing. When a cylinder of a thrashing machine is properly balanced, the frame will not tremble when it is running at a high velocity any more than when it is at rest. The same is true also of a circular saw journal, on which there is a balance wheel.

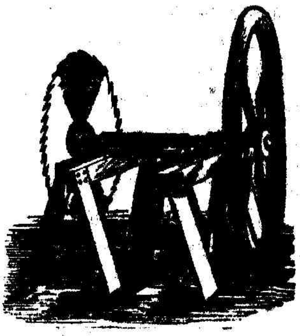
PRACTICAL IMPORTANCE OF HAVING MACHINERY WELL BALANCED.

200. Some kinds of machinery will not operate well if it be not evenly balanced. This is particularly true of the upper mill stone, which runs on the point of a spindle. The stone must be well balanced, or it will not grind evenly. When the journal of a cylinder, circular saw, or any other piece of machinery, is not evenly balanced, the bearings will wear all on one side; and there will not be friction enough on the opposite side to keep them bright.

201. I remember examining the bearings of a cylinder of an old thrashing machine which had run many years without being balanced; and the bearings were as round on one side as when they were first fitted up; while on the opposite side they were worn away nearly one-eighth of an inch, and the surface was not circular, but elliptical. The side that was worn was the heavy side; and at every revolution the greater momentum of the heavy side raised the bearings to the upper side of the boxes, so that when the heavy side was uppermost the cylinder did not rest at all on the bearings. This caused the bearings to wear all on one side, and to run hard and roughly. Every wheel or journal that revolves faster than once each second should be well balanced, not only for the purpose of having all the parts run as smoothly and still as possible, but that the bearings may wear on every side alike.

HOW TO BALANCE A JOURNAL.

202. The accompanying illustration will furnish a correct idea of the means employed to balance the journal of a circular saw, and balance wheel or cylinder. Two steel squares, or iron squares with perfectly straight edges, are placed on two benches, for the bearings of the journal to rest on. The upper edges of the squares must be adjusted with a level, so that the journal will not roll either way when it is placed on them. If one side of the wheel or cylinder descends and oscillates, and at last comes to rest beneath the journal, it is the heaviest side, and must be made lighter; or the opposite side must be rendered heavier, which is done in various ways.



BALANCING A SHAFT.

203. Sometimes small flat knobs are cast on the inside of the rim of a wheel, so that a few ounces of iron may be cut off the heavy side of the rim. This is better than to remove a portion of the metal by drilling holes in the rim of the wheel, as that renders it liable to burst when running at a high velocity. Another common way is to fasten a small piece of lead to the light side of the wheel, until the journal will remain at rest with either side up. If the balance wheel is a *plate* wheel, drill a hole close to the rim on the lightest side, and put in a small bolt, and slip on small washers until the right weight is secured. Cast iron balance wheels are frequently turned off true in an engine lathe. Such wheels will run as smoothly as a top. Cylinders of thrashing machines and power corn shellers are balanced by placing the bearings on the squares, as represented by the illustrations, and boring holes in the wooden staves and pouring in lead. Or more spikes may be inserted. In balancing the cylin

der of a corn sheller, I once drove in nearly thirty spikes more on one side than the other, before it would balance.

204. In order to ascertain how much weight is required on the light side of a cylinder, my practice was to tie on spikes or pieces of lead or nails, until the light side would balance the heavy side; and then secure the desired weight on the light side. It must be kept in mind that the bearings must be turned very true, and the edges of the squares must be very straight, or it will be in vain to balance a journal with any accuracy. After a journal has been balanced as well as it can be on the squares, it is put in its place in the machine, and driven at a very high motion, with the caps of the boxes left off, so that it can rise up and down as it runs, which it will do if it is not well balanced. Now, while it is running at a high motion, hold a piece of chalk about one fourth of an inch above the journal; and the heavy side will rise up and hit the chalk at every revolution. In this way the balancing of cylinders is finished, so that a machine will not tremble in the least.

205. Mill stones are usually balanced by drilling four hol es at equal distances from each other, near the outer edge of the stone; and as it rests on the point on which it revolves, small shot are dropped into the holes in the lightest side, until it will just balance. Another way is, to insert four iron bolts, say half an inch in diameter, in the periphery of the stone or wheel to be balanced. These bolts have a thread cut on them, and pass through a ball of iron, which is screwed outward or inward at pleasure. Thus the stone can be balanced with great accuracy. This is particularly interesting to farmers, as it discloses certain important principles in the construction and use of machinery. I think these few paragraphs will enable most farmers to balance any machinery that they are capable of running skillfully.

206. In Vol. I., I referred to the subjects of fitting up and balancing machinery in this volume; and a certain editor took occasion to cast some reflections on such a branch of agriculture. But, as I now have the floor, it is proper for me to say that if he had worked by my side on a farm for nearly forty years, and

made and handled as much machinery and implements as I have, and witnessed the disadvantages to practical farmers of not knowing more about the machinery that they use, which I have seen and often felt, he would never have intimated that putting tools and implements in order is not very closely connected with "paying farming." A long experience justifies me in stating that, if a farmer does not know how to keep his machines in good running order, he will find it up hill business "to make farming pay."

FARMERS' TRINKETS.

> "A pitchfork, a dungfork, a sieve, skep, and bin:
> A broom, and a pail to put water therein;
> A hand barrow, wheel-barrow, shovel and spade,
> A curry-comb, mane-comb, and whip for a jade."—TUSSER.

207. Little things are often of vast importance; and this is particularly true with farmers. But, as a general thing, farmers are not more than half awake with reference to a multitude of things which have a great bearing on their interests; and there are scores of good farmers who do not avail themselves of the numerous little things within their reach, because they are not aware that there are such things or facilities in existence.

208. A farmer's *time* is often equivalent to cash, and if it is not cash saved it is cash *lost*. When we have really commenced outdoor operations in the field, an hour's hindrance may often be the cause of the actual loss of several dollars, which might have been avoided by the possession of some little trinket or tool which does not cost one dime.

BRACE AND BITS.

209. Every farmer who has not a set of augers, brace and bits, should make up his mind to procure a set at once. Do not purchase one at a time, but go to the hardware store and make a good selection of a full set of auger bits, centre bits, rimmers, screw driver, nail bits, and gimlet bits. A good set can often be purchased for a few dollars. Such a set will soon pay for itself. If you feel too poor to expend such an amount of money at once for tools, take that dime that you are about to spend for tobacco

and purchase a bit with it. A little bit, worth about one dime, has often saved a farmer two hours of his precious time, and, doubtless, several dollars.

CARRIAGE BOLTS.

210. A great many very economical farmers go to the blacksmith's shop and pay ten to fifteen cents for a little bolt, often not half as good as could be bought at hardware stores for two or three cents, simply because they do not know that *there are* such things in existence as carriage bolts. Probably at every hardware store in the country carriage bolts can be obtained of almost any desirable size and length, at so low a rate that one unaccustomed to them would think there must be some error in the price. They are usually made in a most neat and workmanlike manner, with turned heads, and square near the head, to keep them from turning around, when the nuts are being put on, and with a far better thread and fit, of both bolts and burs, than most blacksmiths are capable of making. With us, carriage bolts five inches long are sold by the dozen for thirty cents, and those eight inches long and half an inch square for six cents each.

TIRE BOLTS.

211. These may be obtained of any desirable length and size amazingly cheap. Only think of neat little bolts, two inches long, with turned heads, and a first-rate thread and nuts on them, for three-quarters of a cent apiece! How complete they are for rivets in almost any place, and how much better to bolt on our wagon tires with them than to spike them on.

212. Carriage bolts and tire bolts come in play in a hundred instances, which I will not mention. When hanging doors with *strap hinges* there is nothing better nor cheaper in the end to bolt on the straps with than carriage or tire bolts. When making or repairing any tool or farm implement, where rivets are necessary, they are infinitely superior to rivets, because they are cheaper in the outset, and can be put in in less time; and, when loose, can be drawn up much tighter than rivets. Some farmers always want

a large rivet through their harrow stiles. If they should be put in very tight, as soon as the timber shrinks a little, they are of no benefit at all. But if such rivets were carriage bolts, they could be tightened, and keep the timbers from splitting. Always keep a good supply on hand. They seldom depreciate in value on a farm.

PLOW BOLTS.

213. Most of our plows are bolted together with bolts, having what is called *counter-sunk heads.* Many of the bolts must, of necessity, have a left-handed thread or screw on them. This is particularly true of the bolts that hold the plow points. The lower side of the burrs will frequently hit the earth and stones beneath them; and, were the screw a right-handed one, the nut would unscrew. Such bolts, either right or left-handed threads, can be purchased for from two to three cents a piece, and a blacksmith would want twenty-five cents for making a single one. Another kind of very useful trinkets is

GIMLET-POINTED SCREWS.

214. These, of almost any size and length, can be purchased by the dozen or gross, very cheap; and they are very useful in scores of instances where it would be very inconvenient and impracticable to use nails. Not only those that are gimlet-pointed, but those having the patent thread—not the old-fashioned V thread—are the best, as they will hold better in wood.

OTHER LARGE BOLTS.

215. Farmers frequently have occasion to use long bolts, and much larger than carriage bolts. Now, in order to obtain good ones at the most reasonable rates, purchase blank nuts, which may be had at hardware stores of almost any size—four-square or six-square—and have one nut welded on the end of a rod of round iron for a head, and a thread cut in another for the other end. Blacksmiths usually make such nuts too thin, and, therefore, they do not hold as well as they might. If a bolt is three-fourths of an inch in diameter, the burr, in order to be of cor-

responding strength, must be not less than three-fourths of an inch thick. The true rule for corresponding strength is, the nuts must be as thick as the bolts. In case a man should need a number of large bolts, the most economical way to get them is to procure the iron and have them forged out, and take them to some machine shop and have the threads cut in a lathe. The expense will be much less, providing you have it done by the hour, and they will be far superior than if the threads were cut by an *ordinary* blacksmith. For nuts on such large bolts, those intended for the arms of wagon axle-trees will subserve a good purpose. Intimately connected with bolts are

COTTERELS—WASHERS.

216. When these are purchased by the single ones they will cost from one to two cents a piece; but they should be bought by the pound or gross. These are very useful under the nuts, and sometimes beneath the heads of bolts, and can be obtained of almost any size at ten to twelve cents per pound.

HOW TO MAKE WROUGHT NAILS.

217. Wrought nails, proper, are usually manufactured of a very improper form for most uses, being four-square and pointed — the very best form for splitting anything into which they may be driven, without first boring holes for them. In some cities cut-wrought nails can be obtained at the same price of common cut nails, made of the same form, so that they will not split everything into which they may be driven.

218. When wrought nails are wanted, whether one-penny, three-penny, ten-penny, or six-penny nails, put a quantity of them into the fire some evening, when there is fire enough to heat them to redness, and allow them to remain there until morning. By annealing the most brittle cut-nails in this way they may be rendered as tough as a piece of annealed wire.

219. Cut-fence-nails will be much better after being annealed —when they are not to be driven into hard wood—as they will not break so readily at every little thrust. For making any kind

of implements, even when hard wood is used, the nails should be annealed, and holes bored for them, because a very little twisting and straining on cut nails will break them; whereas, if they are properly annealed, it is very difficult to break them. If farmers would use annealed nails for making their bunks, racks, feeding-boxes, and troughs, instead of ordinary cut-nails, which will often fly into three pieces when struck with a hammer, they would soon be unwilling to use any others.

LOTS OF LITTLE THINGS.

220. I have thought best to enumerate many little articles that few farmers know are to be obtained at hardware stores, which are neatly made, and sold much cheaper than they can be made by hand. Among them are hooks and staples of various sizes; rivets, large and small, long and short; brass and copper rivets, for uniting leather belts; belt hooks of various sizes; clout-wrought-nails in papers, which are designed for nailing leather belts or canvass to machinery; trimming nails of various sizes and colors, and many other useful articles.

CHAPTER II.

SOILS AND THEIR MANAGEMENT.

"Here, barren sands and granite rocks abound,
There, slippery clay and marly beds are found.
But where dame Nature with her skillful hand
Has tempered well the surface of the land
With sand and clay, and covered it with mold,
There Ceres plants her grain like shining gold."—EDWARDS.

221. SOILS are strata of the earth, lying at or near its surface; and, when spoken of in general terms, they are all embraced in the expressions, soil and subsoil.

222. The soil is sometimes very thin, not one inch in depth; and many times it is found to be several feet deep. The *subsoil* is the stratum of earth on which the soil rests, and will be found of different depths, different color, and different in every respect in different localities. And the subsoil is frequently as different in every respect from the soil that lies above it, as the soil of a given locality differs from that in any other locality.

223. Some writers have fallen into the error when writing about soils, of limiting the soil to that depth which is pulverized with tools and implements. But that earth which has been spaded or pulverized with plows one or more feet deep, cannot be properly called soil, unless it has been at some time exposed to the combined action of rains, frosts, heat, vegetation, and thus prepared by the action of those powerful elements of nature for producing crops. Farmers should bear in mind the proper dis-

tinction between *soil*, *subsoil* and *earth*. Earth may be taken from a thousand feet beneath the soil, in which seeds will vegetate; and the plants may come to maturity. But that earth cannot be properly denominated soil or subsoil. It is simply *earth—barren earth* or fertile *earth*.

HOW SOILS ARE FORMED.

224. The time has been when all soils and subsoils were in a state of rock; or, in other words, soils have been formed of stones on the earth's surface. We can perceive all around us the operations of nature's laws, changing and transforming material substances into a multitude of new forms. The intense cold of winter, the scorching sunshine of summer, the gentle rain and dew, and the growth and decay of plants, all exert more or less influence in the formation of soils. But when we reflect for a moment what a powerful agent electricity is to divide, subdivide and to shatter to atoms infinitely small the hardest and the knottiest substances in nature; when we consider that electricity pervades the entire globe on which we dwell, from its centre to its utmost circumference; when we contemplate the vast and unlimited power that was once in operation to heave up to mountain height large tracts of country, all of solid rock, as we may witness all over the Eastern as well as the Western Continent; and when we contemplate the grand and awfully sublime spectacle of vast strata of solid rocks broken up and put in motion, crushing, grinding and reducing each other to atoms, it requires no very great stretch of imagination to understand how soils have been formed.

225. The best geologists tell us, that "soils have been formed by the wear and tear—the disintegration and decomposition of rocks." In other language, the rocks have fallen to pieces, and have been dissolved by the united action of rain, frost and heat; and thus the particles have been reduced so small, that the smallest roots of plants will absorb and appropriate the soluble portions to the purpose of forming plants. A very good illustration of the formation of soils is given in the preparation of gypsum as a

fertilizer for crops. (See Gypsum in the Chapter on Manures.) The rock is first reduced by *mechanical* means—by hammers and mill stones—to a very fine powder. Then, after it has been reduced as fine as practicable by *mechanical* means, it is sowed over the soil, where it is reduced to particles still smaller, by *chemical* means—by being dissolved; and then entering into the formation of plants. Thus it has been with those rocks of which the soil was formed. They have been torn from the vast quarries, as if charges of powder had been deposited at short distances apart throughout the entire quarry, and exploded at one touch of the torch, and afterwards put in motion; and by crushing and grinding, and smashing along, they have been reduced to a fine powder, which powder has been reduced still finer by *chemical* means—by cold, heat, wet and dry, and vegetation, all combined—by the formation of plants, and by their decay, and mingling with the earth on the surface of the earth.

DIFFERENCE IN SOILS

226. From these considerations the young farmer will readily perceive that different kinds of soil have been formed by different kinds of rock. When wells are dug, or when other excavations are made in the earth, strata of earth and small stones will be dug through; and one can perceive with the naked eye that the earth which surrounds the stones has been formed of just such stones as are still remaining. And, more than this, the stones that remain present the same appearance that stones of all sizes would, after they had been rolled and tumbled for a long period of time in a vast tumbling drum, until most of them had been reduced to powder.

227. Every observing man can call to mind instances where he has seen large stones—even after they have been placed in a wall of some building—all falling to fine atoms, thus forming soil. The stones and gravel in our cultivated fields are annually being dissolved by the action of the elements, by the wear and tear and grinding of tools and implements, when they are plowed and harrowed, which often amounts to more than as much as is

usually applied in a top dressing of gypsum. All of these agencies, in connection with the decomposing of vegetation, constitute the great means of forming soils, and of keeping them in a fertile and productive condition. And out of these raw materials the farmer is required to produce subsistence for himself as well as for his domestic animals. Therefore the great and leading idea will be, not only to produce a subsistence from the soil, and leave it, when we are done with earth, as good as we found it, but to manage it in such a manner that it will sustain us and our cotemporaries; and come into the possession of our successors twice as productive as it was when we received it.

SOILS STILL FARTHER DEFINED.

228. A very practical writer in the *Mark-Lane Express* says: "*Soil* means the surface land that is used for the purpose of cultivation, and producing crops from the seeds that are deposited in its matrix. The nature of the subsoil, or under-stratum, is, in many cases, of very considerable moment in the fertility of the land that lies upon it—if it be wet or dry, porous or compact. And then the climate or external influences to which the vegetables of the crop are exposed in the growing and maturing condition; and, lastly, the capacity of the soil for imbibing and retaining moisture and caloric. Soils are very largely varied in the composition, but mostly derived from the decompositions of the rock on which they repose. There are several extraneous bodies intermingled with the soil which have been produced and located by unknown causes; and there are vast depositions of imported debris lying between the rocks and the soil which seem to destroy the direct connection between the parents and the progeny. This interposition is mostly local, and may be reckoned a diluvium from peculiar causes, and in a certain position. Soil is the support of vegetation, and the reservoir of receiving and communicating nourishment. This power is large or small, according to the composition of the soil in the natural ingredients and the mixture of the substances. The chief substances in soils are clay, sand, lime, animal and vegetable matters, some oxide of iron, and

occasionally certain saline compounds. The three ingredients of clay, sand and lime are the principal constituents of soils, along with the valuable addition of animal and vegetable matters, now called *humus*. (See Humus in Chapter on Manures.) The matters which constitute soils are of a compound nature, and operate as such in the formation of them. There are few, if any, substances in nature which after being exposed to and acted upon by the atmosphere and other agents are not capable of affording support to some kind of vegetables, though there is a very great variety in this respect among earthy matters. Some matters are quickly converted into the proper nourishment of vegetation; while others require a long time in being assimilated into a material for sustaining any kind of vegetable life.

HOW SOILS ARE DISTINGUISHED.

229. Soils are distinguished in general terms as *light* and *heavy*. The light soils are those that are composed of light materials, for the most part such as humus or vegetable mold, with a limited proportion of clay or sand, or both. Heavy soils are distinguished from light ones by being composed in a large proportion of clay. "Then we speak of fertile soil, and barren soils, of wet and dry soils; of rocky and mucky soils; of clayey, calcareous, argillaceous, aluminous and gravelly clay; of loamy, sandy loam, gravelly loam, and clayey loam. Besides these, there are many soils that cannot properly be called by either of the foregoing terms; but may be spoken of as a *mixture* of various kinds of soil

230. Every intelligent farmer knows what clay is, and what sand, gravel and vegetable mold is. Now, all soils are composed of these substances; and when any one or two of them predominates in a soil, that soil may be distinguished by those kinds of earth. För example: when a soil is composed mostly of heavy, slippery clay, we call it a stiff clay; although a soil of pure clay is never met with. When there is a good proportion of loam among the clay, it may properly be denominated a clay loam. When there is a good portion of gravel among the clay, we de-

signate it as *gravelly* clay. When a portion of the clay soil has been formed by the disintegration of limestone, we call it a *calcareous* clay.

231. A sandy soil is one in which there is more sand than anything else. But when there is a good proportion of loam among the sand, we call it a *sandy loam.* Sand and clay form loam. Hence loamy soils contain from thirty to sixty parts in one hundred of sand. From loam we branch off to clayey loam and gravelly loam. In addition to these kinds of soil, there is an infinite variety of soils in which vegetable mould predominates, which cannot be classed with the sandy, loamy, or clayey soils. There are thousands of acres, a large portion of the soil of which has been formed of limestone, that are called calcareous clays, calcareous loam, or calcareous sand.

232. Alluvial soils are such as have been deposited by the action of streams of water; and they may be as varied in their composition as any other variety of soil. But, as a general rule, there is a large proportion of vegetable and mineral matter mingled with them, which renders them very productive.

FORMATION OF PRAIRIE SOILS.

233. The soils found on our prairies in the western part of our country are quite different from all others that have been mentioned, on account of the peculiar manner in which they have been formed. For ages past the large crops of prairie grass have been allowed to decay where it grew; and, in many instances, fire has swept over most territories, and reduced the dry vegetation to ashes. And as the roots have brought up the soil, and it has been formed into plants, and then burned to ashes, a soil of a very peculiar character has been formed, which abounds richly in materials for producing large crops of all kinds of cereal grain as well as grass, and anything else that farmers desire to cultivate. Such soils may properly be denominated *vegetable* soils. I might pen page after page concerning soils, which would be of interest to read. But, as most farmers want only a few practical and tangible thoughts on this subject, I have

thought it best to write briefly. Most farmers are more interested in cultivating their own soils well than they are in directions for cultivating soils of a different character in another part of the world. (See Allen's American Farm Book.)

CHEMICAL CLASSIFICATION OF SOILS.

234. The editor of the *Mark-Lane Express* says: The best classification of soils is a chemical classification, founded on their composition, according to the proportion of sand separable by washing; it divides them into sands, sandy loams, loams, clay loams, and clays. It subdivides those again into fine and coarse sands and sandy loams, according to the size of the particles of sand, and into gravelly sands, loams and clays, according to the proportion of pebbles or fragments of rocks. The proportion of calcareous matter indicates whether they are to be called marly or calcareous sands, loams, and clays; while, if they contain a certain proportion of vegetable matter, they are called vegetable soils. Each name should express some defined proportion of sand separable by washing, and of calcareous or vegetable matter. *In such a classification as we advocate, we should have:* 1. *Silicious soils*, containing from 90 to 95 per cent. of sand. These would be divided, on the same principle, into blowing sand, coarse sand, good agricultural sand, and calcareous sand. 2. *Loamy soils*, 70 to 90 per cent. of sand separable by washing, subdivided into coarse sandy loam, fine sandy loam, loam, rich loam, and calcareous loam. 3. *Clayey soils*, with 40 to 70 per cent. of sand, divided into clay loam, clay, and calcareous clay Each of these soils, termed calcareous sand, calcareous loam, &c., contain five per cent. of lime. *Marly soils* constitute a fourth group, in which the proportion of lime ranges between 5 and 20 per cent., and are divided into sandy marls, loamy marls, and clayey marls. *Calcareous soils* contain more than 20 per cent. of lime. They are divided into sandy calcareous, loamy calcareous, and clayey calcareous; while in calcareous sands, clays, and loams, the proportion of lime does not exceed 5 per cent. The difference of composition denoted by difference of name is similar to the

sulphates and sulphites of chemical nomenclature, which contain different proportions of sulphuric acid. According to the quantity of pebble fragments yielded by a square yard, or by a cubic foot of the soil, they might be denominated *gravels* or *gravelly* sand, loams, and clays. *Vegetable soils* vary from the common garden mould, which contains from 5 to 10 per cent. of vegetable matter, to the peaty soil, in which the organic matter is about 60 to 70 per cent. They will be vegetable sands, loams, clays, marls, &c. Considered geologically, soils may be classed in three groups: 1. *Local soils*, or those derived exclusively from the debris of the rock on which they rest, unmixed with the materials of other rocks. 2. *Erratic soils,* containing the mixed materials of several, and, in many cases, distinct formations, transported by currents of water which, at the close of what is called the tertiary period of geology, acted irrespectively of the present lines of drainage and sea levels. 3. *Alluvial soils*, composed of finely divided matter, transported and deposited by rivers and tidal currents, in subordination to the existing levels and lines of drainage.

CLAY AND CLAY SOILS.

235. "Clay is a viscous earth of marine or fresh-water origin, ductile and plastic, capable of retaining the moulded forms; imbibes fifteen times its own weight of water without dropping, and retains it with great obstinacy. A very considerable quantity of clay is necessary in the composition of soils; it is the basis of all good lands; there cannot be a rich-bearing earth without some clay; conveying a vast chemical superiority, though with a mechanical disadvantage. Clay is required to imbibe and retain moisture, and its value depends on the quantity in the soil. An excess of clay produces a starved barrenness from too much moisture: the want of it forms weak lands, dry, and barren." Clay is an earth, the base of which is alumina; and alumina consists of the metal known as aluminum united with oxygen. Clay may be further defined as a heavy, soft, and slippery earth when wet; and when dry, compact, brittle, and hard. Pure clay is said to be white. But it is rarely found in its pure state. It is

almost always mingled with other substances, which modify its color as well as its texture or solidity. We frequently see allusions made to aluminous clay and aluminous earth, which means almost pure clay. Then we have silicious earth or clay, in which there is a good proportion of silica or flint, sand and quartz. Other writers allude to argillaceous earth or soil, to denote that the purest kind of clay predominates. In many localities the clay is properly of a calcareous nature—called a calcareous clay—which signifies that there is a large proportion of lime in the soil. Then we have what may be termed a calcareo-argillaceous soil, which contain a good portion of calcium and argil, or aluminum. Clay is sometimes almost red, which is colored by the iron in it. Other foreign substances give different colors to clay, imparting sometimes a bluish, and sometimes a brown tint. Almost all soils contain more or less clay, although in some the amount of clay is so small that it may be said to contain no clay at all.

236. One of the great excellencies of clay soils is, the capacity and power of retaining fertilizing matter for promoting the growth of plants when there is not an excess of water. When clay soils are wet they will retain such substances as well as when dry; but an excess of water will render the soil so very compact that the roots of plants cannot avail themselves of the food that exists in abundance throughout the entire soil. When the pores of the soil are filled with standing water none but the roots of aquatic plants will grow in it. And even then, unless the soil be kept constantly wet, such roots will die when the clay comes to dry and shrink and crack under the influence of the sun.

PREPARATION OF CLAY FOR TOP DRESSING.

237. If we dig up clay in chunks that has never been exposed to the alternate influences of freezing and thawing, and drenching rains, and scorching sunshine, and place it where it can freeze and thaw a few times during the winter, instead of remaining in heavy, soggy, melastic masses, it will crumble to fine powder, which may be shoveled over or spread around with comparative ease. Now, in using clay as a top dressing, or in ming-

ling it with sandy soils, the great idea is to save hard labor, and to derive as much benefit as may be practicable from the clay the first season it is applied to the soil. If it is to be mingled with a sandy soil after it has been hauled half a mile or more, which may be done in some States during the winter months, let it be spread on the soil where it is needed, whether meadow or plow land, and in the spring all the compact chunks will be reduced to a fine powder, which may be spread evenly over the surface But if the clay is to be used as a top dressing for hoed crops, it should be drawn at the former part of winter near the place where it is to be used, and spread on a smooth plot of dry ground, about eight or ten inches deep, and about ten or twelve feet in width, and then a temporary shed of boards erected over it to carry off the rain. Should it all thaw out during the winter, let the boards be removed, and let the whole of it be plowed over, cutting very narrow furrow slices, and covered up again to keep off the rain. By keeping off the rain, and by plowing it over several times, it will be so mellow and fine by the time it should be applied to the growing crops that it can be shoveled and spread with comparatively little labor. On deep mucky soils a top dressing of clay will produce heavier grass than a dressing of barnyard manure. And on very porous sandy or gravelly soils a small shovelful of pulverized clay to a hill of potatoes or Indian corn would produce more grain than a dressing of most of the kinds of fertilizers sold in manure markets.

HUMUS IN SOILS.

238. That portion of a soil which we scientifically denominate *humus* is the same substance that farmers ordinarily call *mould*, comprehending the organic matter in all soils which has been formed by the decay of vegetation and animal substances at any previous period of time. In some soils it is found in great abundance, and in many others it appears in only limited quantities. It constitutes the greatest source of fertility in every soil, as is abundantly proved from the fact, that when no humus is to be found in a soil it will be as unproductive for cereal grain as cold,

soggy, calcareous clay, or barren sand Scientific writers call it by various names, such as humic acid, humin, humic extract, and the decayed carbon of acideous residue of plants and animal substances. Humus exists in as many different forms as carbon. Chemists tell us that the diamond—" more precious than silver or gold"—and black charcoal are composed of pure carbon. But how vastly different their appearance! Humus is also called vegetable matter in a state of decay. Peat and turf, when they are in a state of decay, are sometimes called *inert* humus. Although a certain amount of humus is essential to render a soil productive, still where it exists too abundantly it operates as a source of *in*fertility rather than of fertility. Farmers may readily recognise humus when they meet with it in their fields. On new lands just cleared of the forest, decayed brush, leaves, rotten wood, which has crumbled to a black mold, and the thin super-stratum of black earth on the surface of any compact soil is humus.

THE OPERATION OF HUMUS.

239. The influence which humus exerts on vegetation is a two-fold one—*mechanical* and *chemical*. When it is mingled with a clay soil it renders it porous, light, friable, warm, and easily worked. It keeps the soil from running together like mortar, as it allows the water to percolate through it quickly, and it prevents its baking, in hot weather, by conducting off the water quickly and keeping it porous for the admission of air. This is the *mechanical* influence.

240. The *chemical* influence may be thus explained. Chemists tell us that it absorbs nitrogen from the atmosphere during its decay, which is almost constantly going on, and thus becomes converted into ammonia and nitric acid, which are excellent substances in promoting the growth of vegetation. It also forms carbonic acid, which is the very life of all our cultivated plants. These are *chemical* influences. (See this subject elucidated under the head of Mechanical and Chemical, Chapter I.) These substances unite with others in the soil; and thus, by farther chemical changes and influences, excellent food is formed for the

roots of growing plants. The organic matter (humus), when formed in wet places, constitutes muck and peat, which are not fertile; but as it occurs in arable soils, in quantities usually not exceeding 3 to 10 per cent., it is of great value, not only on account of its power of absorbing water, but also from the fact, that in its decay it is a continuous source of carbonic acid and ammonia, thus satisfying, to some extent, one condition of rapid growth already insisted upon, viz.: supplies of atmospheric plant-food by the soil. The carbonic acid formed in the soil by the slow oxidation of humus acts also according to the amount of its production in the chemical disintegration of the insoluble parts of the soil, and thus indirectly furnishes to the plant increased quantities of ash-ingredients.

SAND AND SANDY SOILS.

241. Sand is the particled granulation of rocky substances that have been reduced by the action of water, and have been carried about and located by the aqueous agitations. The quartzy and silicious formation prevents any cohesion of sand, which is loose and incoherent; and when dried, it is blown by the wind. It possesses not any fertility, but it is usefully mixed with other substances, and, in the proper quantity, promotes the openness of soils that is necessary to fertility. Sand varies in color about as much as clay, and its excellence for agricultural purposes differs about as widely as the excellence of clayed soils in their great variety. If we wash a handful of sand, and examine it with a microscope, it appears more like a heap of sharp-cornered, rough-looking bowlders than anything else. The fertility of sandy soils arises, for the most part, from the *mechanical* influence which the sand exerts in promoting vegetable growth; and the great excellence and efficacy arising from the sand in clayey soils consists in its rendering the clay more porous, so that the numerous roots of plants may spread very readily through the soil. The sand does not supply nourishment, except in a very limited degree. The little roots find their way through the soil, where there is a good proportion of sand, about as readily as insects—

worms and bugs—crawl downward through heaps of small stone.

242. Every intelligent farmer knows what quartz and flint stone is. Sand is formed from this hard and flinty rock. Sand is not formed of slate, or hornstone, or limestone. Sand furnishes material for growing plants that gives stiffness to the stems. For this reason cereal grain, that grows on sandy soils, always keeps erect much better than when it grows on mucky soils, where there is a deficiency of silex, or silica, for imparting stiffness to the stems. The *Genesee Farmer* says: "The immediate effect of sand applied to clay is to make it into a more adhesive mortar; and anthracite coal ashes, unless in large proportion, will have the same indurating effect; but if coarse vegetable or stall manure, or a stiff clover sod is applied with the sand, and both are plowed in, in the fall, so that the frosts of winter can act on the furrows, then a thorough amelioration takes place, and you have the next season a friable soil of great fertility, capable, with subsequent good tillage, of standing both wet and drought. But to keep up this condition of the soil, it must be well underdrained, and an occasional rotation of a clover crop, with the sod and a little manure plowed in, must not be omitted. The action of frost on clay is allied to that of burning the clay; the aluminous base of clay seems to lose its strong adhesiveness by burning, and the finely comminuted sand that is precipitated is identical, apparently, with the fine sand of the richest river bottoms, which, it has been said, cannot be worn out by ordinary cropping. At any rate, such a soil is more capable of holding water by absorption, and decomposed organic matter by chemical attraction, than by any other equally absorptive soil.

THE FERTILITY OF SOILS.

243. The question is often asked on what the fertility of super-soil and subsoil depends? And it has puzzled a great many wise heads to give a correct answer to such a simple interrogation. Soils from different parts of the country have been carefully analyzed, and the analyses have turned out to be exactly

alike. But in productiveness, one was called a *barren* soil, and the other a *productive* one. Writers have theorized and philosophised about it, and penned elaborate essays in giving the true answer to this simple question, which may be answered correctly, scientifically, and practically in only a few words, which are—*the fertility of the soil depends on the amount of available nourishment which it contains.* This comprehends it all.

244. A man may understand correctly what ingredients are necessary to constitute a fertile soil, and he may determine whether those ingredients are to be found in the soil, or whether they must be supplied. But, after all that is said and done, if those ingredients are not in an *available* form for promoting the growth of plants the soil cannot be called a fertile one. Some writers have supposed that when one soil was barren, and another exactly like it in its chemical composition was very fertile, its fertility must be traced to the exceeding fineness of the particles in the fertile soil, and to their coarseness in the barren soil. This is correct so far as it goes. Of course the nourishment in the very coarse particles of earth is not available by the roots of plants. And it might not be any more available were it reduced, by mechanical means, to a very fine, impalpable powder. Before substances can be available by the roots of plants, they must be reduced to a liquid or fluid state, and even after they have been changed to a liquid state, they may still not be in an available condition for promoting the growth of plants. All vegetable nourishment, whether it is in the soil or in the atmosphere, must, necessarily, be in *such* a liquid or fluid state that the roots and leaves of plants will take it up. Plants never take up *solid* materials, and they will never absorb liquids and fluids, *when they are in a certain condition,* any more than they will absorb solid substances.

ERRORS IN CULTIVATING SUBSOILS.

245. The subsoil or under-stratum which supports the cultivable layer, if it be earthy or rocky, compact or porous, influences the productiveness of soils. A sandy soil may owe its

fertility to the power of the subsoil to retain water; and a wet, clayey soil may be much benefitted by a subsoil of porous sand or gravel. It is well known that soils, when only a few inches in depth, and on beds of cold, wet clay, rock, or chalk, are by no *means so fruitful and productive as those which are deeper,* though of inferior quality, but resting on a bottom which is dry and gravelly. The difference of weight and tenacity in the understrata of soils likewise introduces great variety in regard to their powers of raising and rearing vegetable productions in the way of crops upon them. As farmers, generally, have not made themselves familiar with different kinds of soil and subsoil, we have too often seen them experimenting with subsoils at a very costly rate. One farmer, whose soil was very deep, has run his plow deep, and turned up three or four inches of new earth, which he called subsoil, which has increased his crops more than double the usual amount. Another, whose soil was very thin, containing only a small proportion of mould, and resting on a stubborn and compact subsoil, has turned all the mould that has been slowly accumulating for ages past, eight or ten inches below the surface, and brought up several inches in depth of this cold, unfriable, unfertile subsoil, with the expectation that this soil would produce a very bountiful crop, when, to his great disappointment, he finds that the productiveness of his soil is materially injured for many years to come. Many farmers, in different parts of the country, who were ignorant of the character of their subsoil, have plowed deep in the spring for a crop of Indian corn; and as the subsoil was often wet, cold, and barren, not half a crop was raised. Therefore, by not understanding how soils are formed; how long time is required to make a productive soil out of the materials that are near the surface of the earth; and by not understanding wherein consists the source of fertility of all soils, deep plowing and deep cultivation have been condemned; scientific agriculture has been denounced; and "Book Farming has been blown higher than Dr. Franklin's Kite," simply because deep plowing—turning up the unfertile subsoil—proved an injury rather than an advantage.

SUBSOILS—THEIR CHARACTER.

246. We have seen in a previous paragraph what constitutes the subsoil. Now the great idea above all others is to be able to manage them in the best and most profitable manner. Subsoils are almost as various as soils. But we shall distinguish them as compact and porous, barren and fertile. The most fertile and productive soils can be made of subsoils by proper management. But it cannot be done in one year, nor in ten years. Some kinds of subsoil may be changed into good soil in a short time, and at a comparatively small expense, while other kinds will require peculiar treatment for many successive years. There may be a great abundance of the elements of fertility in a certain subsoil, but if those elements be not in a condition to promote the growth of plants they will be but little better, for the purposes of vegetation, than sawdust and charcoal are for nourishing animals, notwithstanding those substances are composed, in a great degree, of carbon, oxygen, and other substances, that form the very best of nourishment.

247. The subsoil of the farm that I formerly owned was as variable as the many different mixtures of the soil. In some fields, where underdrains were cut three feet deep, the subsoil would consist of a light-colored gravelly and clayey loam, which would produce as good turnips or cereal grain the first season that it was thrown to the surface, as the soil. On the other parts of the farm the subsoil, only ten inches below the surface of the ground, would be stubborn, lumpy, destitute of friability and barren, and would have to be manured, clovered, plowed in the fall, and the lumps crushed with a roller, year after year, before it could be brought into a moderately good state of fertility. And these are common characteristics of different subsoils all over the United States. And the true way for every farmer in managing them is, to test their fertility to a limited extent in every field before he plows very much of it to the surface of the ground. (Read the Ill Effects of Deep Plowing in the next Chapter.)

HOW SUBSOILS SHOULD BE CULTIVATED.

248. We have seen, in a previous paragraph, that all good soils must contain a good proportion of vegetable matter. Now, if there be but a thin super-soil, and only a limited amount of mould in it, only one inch or two in depth of that subsoil should be turned up on the surface. And whatever may be the character of the subsoil respecting its fertility, it should not be turned up *in the spring of the year.* (See *Fall Plowing in next Chapter.*) The true place for all kinds of subsoil—except in certain instances where the soil is of a peculiar character—is beneath the surface soil. There are thousands of acres of the very choicest quality of wheat land in New York and other States where the soil should never be inverted more than four or five inches deep. The subsoil should be loosened with a subsoil plow, and be kept below the soil. On the slopes of most of our lakes, where the soil contains but little vegetable matter, deep plowing would be the very worst system of cultivation that could be adopted. After a furrow has been turned with the common plow, the more thoroughly the subsoil can be mellowed up with a subsoil plow —(See Cut of Subsoil Plow in the Chapter on Plowing)—the more complete and scientific will be the system of cultivation, and the more abundant will the crops be on such a soil.

249. I advocate deep cultivation and deep plowing. And the deeper one can plow the better it will be for the soil as well as the crops. But every farmer should be exceedingly careful not to turn up too much of the subsoil to the surface unless there is too large a proportion of vegetable matter in the soil. The aim should always be, as far as may be practicable, to keep the mould on or near the surface of the ground. Let not the reader misunderstand me on this subject. I repeat the thought to plow deeply; and, at the same time, I reiterate the caution that where a soil has but little mould on the surface the plowing must be done by simply plowing only a few inches deep with a common plow, and then *following* with a subsoil plow. (See this elucidated hereafter in Paragraph 250.)

KEEP THE BEST SOIL ON THE SURFACE.

250. In Europe, on many of the most productive farms in the country, tenants are bound in written contract "not to plow up any meadows." And why? The theory is, "if old meadows are broken up, the decay of the sod will yield several large crops of cereal grain or grass. But, after it has been seeded down again, the grass crop will continue to diminish for a number of years, until a coat of carbonaceous matter or mould has been formed on the surface, when it will again increase in productiveness." Where land is cultivated in this manner without supplying an equivalent amount of fertility, it deteriorates in value, and requires time to restore its original condition. If grass land is plowed for grain, its fertility must be maintained. Every farmer knows that one of the first requisites is, there should be on the surface of the soil a stratum of carbonaceous matter, or what is colloquially termed *mould*. This will aid, facilitate and promote the quick germination and rapid growth of seed and tubers. Then, if the soil beneath this mould abounds in manurial substances, such as roots of plants will appreciate in the production of various kinds of crops, and has been prepared by some mechanical means—or made mellow—for the easy ramification of the roots, we have a soil in the most excellent condition for producing any kind of crops to which it may be adapted.

251. When a soil is not excessively wet, nor too dry, the roots of any kind of plants that take up the most nourishment are those which are nearest the surface of the soil. It appears always to be an essential consideration in vegetable physiology, that the surface of the soil should be covered with a little mould in order to aid the growth of plants. When we go into woods, for example, where the soil is covered with a thin stratum of mould, we see the entire surface occupied with young plants early in the spring of the year, which would never have vegetated if they had not been in such a favorable place. So it is in the cultivated field. If all the mould on the surface of *some kinds of soil*—not of every soil—be turned beneath the surface

several inches, and the compact mouldless soil or subsoil be brought to the surface, every good farmer need not be told how difficult it is to get a good sod formed on the surface; and also how much more liable winter grain is to be lifted out by the freezing and thawing of winter.

252. When planting Indian corn, we all know how important it is to have a few inches of mould on the surface, in order to give the young plants a "good start." So it is, also, when raising turnips, carrots, parsnips, and anything else that springs from very small seed. The surface of the soil lying in contact with the air, if rich and finely pulverized, aids germination very much. The operations of Nature in the forests, around all stumps, and along decaying logs and fences where seeds germinate; vegetable physiology, sound philosophy and the best practice of the best farmers all combined, coincide and unite in this one consideration, that it is the best system of cultivating the soil, for any kind of crops—grass not excepted—to keep the best soil and a little mould on the surface, as much as may be practicable.

MAINTAINING THE FERTILITY OF SOILS.

253. Mr. JOHN JOHNSON, Geneva, New York, in answer to some inquiries, in the *Country Gentleman*, with reference to his manner of maintaining the fertility of his soils without resorting to foreign manure, replied : "There is no difficulty in doing that on all our clay subsoils in this part of the state. In the first place you must feed your stock well all the year, and keep them improving both in summer and in winter. Keep them in yards from the time the pasture won't afford them a sufficiency in autumn until there is pasture enough in spring to support them fully. Then apply the manure made in winter, and *take care not to overstock your pasture land* in summer, as by so doing you are not improving nor resting your land by letting it lay in grass, if it is all eaten off as fast as it grows. Let the land be covered with grass or clover, and it is getting fat daily; and so will the stock. I also have sown one bushel of gypsum to the acre, on all my

meadows and pasture land ever since I commenced farming here. By rigidly following up the foregoing system, my farm has become far more productive now than it was thirty-five years ago, producing double the quantity of hay and pasture and corn or oats, and the wheat crop is also more productive. If we had dry summers, wheat would stand much higher manuring, but we do not know what the summer is to be until it is past; therefore it is safest to manure only moderately for wheat. For corn or grass I have never reached the point where I thought too much was applied. This buying of dung at city prices may pay, and I suppose does, to raise vegetables for New York or other large cities, but I cannot believe that it can pay to raise grain or grass. It is something like a farmer buying his bread and meat. I know that every farmer can, in this part of the country, make manure enough to keep up the fertility of his farm with stock and clover if he tries to do it. I have kept about one-third and sometimes one-half of my farm in grain crops yearly since I owned it, and the result is that it is far more productive than when I commenced on it; and every one that knows it now and knew it then, knows that what I write is true. Manure, however, will be consumed much sooner in much of the land on Long Island, than on our drained clay lands in this part of the State of New York." The reader should keep in mind that I advocate in this treatise no other system of farm management than that which will be self-sustaining—by which the intelligent farmer will be able to maintain the fertility of his soil, with the materials that the farm affords.

254. In addition to the foregoing remarks, I have copied a portion of a letter from Mr. Johnston, who imported into this country the first drain tile and tile machine; and who gave us an excellent practical illustration of the manner of restoring and improving the fertility of a worn-out farm by thorough draining and barnyard manure. He says: "If our farmers would only make all the manure they can on their own farms, they would have no occasion to resort to guano or chemical manures. It may perhaps be profitable to import guano, and to apply to che-

mists to manufacture manures in Great Britain, where produce enough cannot be raised to feed the population; but not so in this country, where we raise a large surplus for exportation, and a great deal that is worse than wasted in manufacturing intoxicating drinks. If our farmers would convert their coarse grains into mutton, pork and beef, I believe they would find it more to their profit than selling them."

MIXING DIFFERENT SOILS.

255. By referring to alluvial soils, the reader will perceive that when an alluvial soil is composed of about equal parts of clay, sand and humus, it will be a very rare instance in which another soil will excel it in productiveness. Taking the hint from this consideration, we find frequently that an excellent job may be performed by mixing the different kinds of soil in many of our cultivated fields. On many farms, all over the United States and Canada, there are low lands and high lands in the same fields which vary in height and depth only a few feet; and the leaves of the forest and the decayed vegetable matter has been accumulating in the low lands for ages unknown, so that there is but little vegetable matter or humus on the knolls or high ground. Here, then, is an instance in which too much of a good thing is not found to be as beneficial for producing crops as a smaller quantity would be.

256. Now, then, we want to get a large proportion of this light soil in the low places, back on the higher ground, where much of it once came from. But the great barrier in the way of accomplishing this object is, the vast labor required to remove a few inches in depth of soil to another part of the field. But if such light soil can be removed and mingled with the heavy and compact soil on the high ground, a better effect will often be produced on the fertility of the soil than there would be by the application of a liberal dressing of manure. As it is a much easier matter to tell what ought to be done, concerning mixing soils, than it is to do it, I propose to give some of the

DETAILS OF EXPERIENCE IN MIXING SOILS.

257. Although my farm was called a level farm, there was much high ground and much low ground. And in some places in the low ground the light, dark-colored soil had accumulated—at the expense of the soil on the high ground—to the depth of eight to twelve inches. On the high ground, in some parts of the field, the super-soil, not more than three or four inches deep, rested on a stiff, calcareous clayey loam in some instances; and in others on hard pan, or on a stubborn subsoil of gravelly clay, which was very hard to cultivate for almost any kind of crops. I have my mind, at the present writing, on a portion of one field that was about two feet higher than a strip of low ground. This high ground was well underdrained and manured liberally very often. But the ground where I never allowed any manure to be distributed, would always produce more than twice as much per acre as the high ground. But I found there was nothing superior to a coat of the soil from the low ground spread on the high ground, to increase its productiveness for any kind of crops—grass not excepted.

258. My manner of mixing such soils was to have the soil that was to be removed plowed up in a mellow condition, and then with a team and dirt scraper scrape off a few inches in depth and haul it to the higher ground. One man with a team could hold and drive, and haul soil six or eight rods faster than he could do it in any other manner. And a man who has never performed any such labor would be astonished to see how much soil one man and a team would remove several rods in one day. I worked at this at any season of the year when the soil was not wet enough to adhere to the scraper. Many a day has the writer removed soil alone with a team and scraper; and after the two kinds of soil were well mingled together, the good effect on the crops at such places was always more satisfactory than when only a coat of manure was applied. After a few inches in depth of the light soil had been removed, a portion of the subsoil would be turned up—if it could be reached with the plow—and mingled

with the light soil. This subsoil always increased the productiveness of that kind of soil more than a top dressing of manure.

REMOVING SOIL WITH A WHEEL-BARROW.

259. Let six or eight narrow plank be placed end to end for the wheel to run on, and let the soil to be removed be plowed, and then let it be wheeled and spread on each side of the plank for ten or twelve feet. Then carry the plank along, and cover another plot as already done. If the soil is mellow, and not full of water, an active laborer will remove and spread a great many cubic yards of soil in a day. Still another way is where the distance is too great to carry soil with wheel-barrows, or with a team and scraper, to haul it on wagons. Let the bottom or platform be made of light scantling, about three inches square, with the ends shaved round, so that one man can drop a load of soil in a very few minutes; and then use two wagons, and let one or two laborers load the light soil, and one man haul and unload it. Every dollar that is expended in this manner will be returned with interest in the increased amount of the first two crops—and many times in the first crop—that such soil produces.

260. The easiest and most expeditious way to spread soil evenly that has been dropped from a scraper or wagon is, to fasten two large pieces of scantling together, in the shape of a three-square harrow, and hitch a team to it, and let the driver ride on it. One man with a team will be able to spread more earth, and such a dirt spreader, than ten men would spread with shovels. Another important consideration is, to drop the scraper loads in rows a few feet apart, and drop the earth from wagons in small heaps, which will facilitate spreading it.

IMPROVING MUCKY SOILS.

261. In many parts of the country the entire soil, with an occasional knoll of sand, loam, or clay, consists of black mould or muck, which is often so deep that it is impracticable to turn up with the plow any of the subsoil on which it rests. In such instances earth must be hauled with wagons and mixed with soils

of this character, to give them firmness and solidity for grass or any kind of cereal grain. Therefore a thin covering of clay spread over the entire surface in autumn or in winter, where it will be exposed to the dissolving and disintegrating influences of frosts and rains, will tell more effectually on the productiveness of such soils than two crops of clover plowed under or a good dressing of barn-yard manure. Such soils do not need improving with clover or any other green crops. They lack *mineral* fertilizers, or they lack what we scientifically denominate *inorganic* manure, which clay will furnish in unlimited abundance. Therefore a farmer need not be at the expense of attempting to improve the fertility of such soils by the same system of management that would be necessary on a heavy soil. Apply clay—this heavy, unctuous, slippery clay is just the stuff—and every load will be more valuable in rendering such a soil productive than a load of ordinary barnyard manure. If clay cannot be obtained get clay loam, or this compact, calcareous, gravelly clay. Plow up some hard barren knoll, or scrape away the super-soil, and plow up the subsoil, and spread it on the mucky soil. Every time such light, porous, mucky soil needs the application of some fertilizers apply a dressing of clay until its texture has been so changed that it may be said to consist of one-sixth or one-tenth part of clay. But a dressing of barnyard manure every time clay is applied will also increase its productiveness.

SANDY AND GRAVELLY SOILS.

262. Where sand and gravel predominate in soils to such a degree that a good shower of rain is needed almost every day to keep vegetation from drying up, nothing will improve them so well as a dressing of clay. And the next best dressing will be clayey loam. When neither of these kinds of soil is at hand, muck or peat, or some other kind of earth mingled with the sandy and gravelly soil, will tell a good story on its productiveness. Such soils that are too open and porous to retain moisture require clay mingled thoroughly through them, so that they will be more retentive in holding moisture and the fertilizing substances

that promote the growth of all kinds of plants, and then they need mould, humus, muck, clover, or maize, or barnyard manure, to make them productive.

263. We have read of experiments in applying clay, after it had been finely pulverized, to Indian corn in the hill on sandy soils, and the effect was to increase the quantity of grain per acre quite as much as a dressing of hog-pen manure did when applied to some of the other rows in the same field. A shovelful of clay applied to a hill of corn, when properly prepared, would operate on a sandy soil in a most beneficial manner. If it were sprinkled around the hill—as it should be, and not thrown in a heap as it should not be—so as to cover an area of ground about two feet in diameter, much fertilizing material would be furnished for the roots of the young plants, and it would operate as a good mulch for retaining the necessary moisture in which sandy and porous soils are often deficient.

264. When pulverized clay is applied to Indian corn in this way the fertilizing matter will be passing down to the roots during all the growing season. And the good effect will be as great on the crops for two years after it was applied as it was the first season. A top dressing of pulverized clay would be excellent on a porous, sandy soil, when roots of any kind are raised, if it were prepared properly, and applied after the young plants had got a good start.

265. The editor of the *Country Gentleman* writes: "In almost every section of our country there are tracts, of greater or less extent, of sandy, gravelly, or light loamy soils. Even in New England, notwithstanding the mountainous and rocky character of many sections of it, in the aggregate there is within its limits immense quantities of light sandy lands, which generally, when spoken of, are designated as 'pine lands,' as the original forest growth when the country was first settled was most composed of the white and other varieties of pine trees. These soils are the result of past geological agencies, and, by geologists, are termed drift or diluvial, while the lower-lying lands, bordering our rivers and smaller streams, are called alluvial soils; in some

sections they are termed 'bottom lands;' in other, intervales. The alluvial or intervale lands are frequently the most productive and valuable lands we have, though they vary somewhat in natural fertility and agricultural value.

266. "The diluvial or sandy soils, generally forming the second terrace above the rivers, vary greatly in their natural fertility and agricultural value, aside from their nearness to or remoteness from markets. These differences are generally owing to the chemical, mineral, and physical composition of the earthy materials forming them; some of which, if they can be called soils, consist almost entirely of fine silicious sands, destitute of vegetation of any kind. Large tracts of such are found on Cape Cod and elsewhere. There may be particular locations and other conditions where the reclamation, by heavy dressings of clay or muck and manure, of such 'blowing sands,' may be made to pay in the production of excellent crops of grass and cereal grain."

GENERAL DIRECTIONS FOR MIXING SOILS.

267. In nearly all parts of the country different kinds of earth are found deposited in hills, knolls, valleys, and plains, in sufficient abundance to improve such soils as need improvement by mixture. Wherever we find heavy, slippery clay soils, we shall almost always find, within a convenient hauling distance, hills of gravel or sand, or both, as well as beds of muck and stores of excellent sandy loam, or some other kind of earth that will improve the productiveness of a soil whose preponderating ingredient is heavy clay.

268. In many localities there may be found inexhaustible deposits of excellent alluvial, which will have an excellent effect—both mechanically and chemically—on any kind of soil that may be found on the uplands contiguous to it.

269. The intelligent farmer will be able to understand from these remarks that when it is recommended in making and applying manures to soils to use muck and peat in composting or in absorbing the liquids of stables and stock yards, the soil to which the manure is to be applied is not a mucky soil, but, on the

contrary, one that is different in its texture and composition from the kind of earth that is to be applied to or mixed with it. Let clayey soils have a dressing of sand, fine gravel, muck, or sandy loam; let sand receive a proper admixture of clay; let mucky soils be dressed with some compact soils or earth, as clay, clayey loam, or gravelly clay. Light mucky or peaty soils may often be much improved by a sprinkling of sand or sandy loam, where earth of a clayey nature cannot be conveniently obtained.

270. In some parts of our country there are inexhaustible deposits of marl. Now, in case light and mucky soils are near such deposits, their productiveness may often be increased fully one-half by a liberal dressing of the marl, even when it may have to be dug from several feet below the surface of the earth. These few ideas, in connection with what may be learned under the head of Deep Plowing and Thorough Pulverization, in the next Chapter, will be sufficient to enable every farmer to manage his soils in a very satisfactory manner. But, it must be borne in mind, that the great proportion of the soil of our country can be improved by deep plowing, in connection with clover and barn-yard manure, better and cheaper than any other way.

MIXING SOILS IN NEW ENGLAND.

271. A farmer of Vermont records a little experiment for the *American Agriculturist*, which proves that a top-dressing of yellow loam to a clay soil operates very satisfactorily. He writes: "I had a piece of ground which had become reduced by a succession of crops, so that it produced only five hundred pounds of hay to the acre. I wished to dig a cellar under my barn, and concluded to try an experiment with the earth which was taken out. I measured off one acre of the field above mentioned, and drew the earth from the cellar upon it, covering the piece to the depth of two or three inches when it was evenly spread. This was turned under, the same autumn, to the depth of six inches. The next spring it was harrowed thoroughly, and one half planted to potatoes, and the other half sown to oats. The result was one hundred and twenty-five bushels of potatoes, of as fine a

quality as I ever raised, and thirty bushels of oats. I again plowed it in the autumn, going two inches deeper than the previous plowing. In the spring I thoroughly mixed and pulverized the soil, and sowed to wheat, and seeded to clover and timothy grass. I had a stout growth of straw, but owing to the weevils, the yield was about 15 bushels of wheat. I have since cut two tons of hay to the acre for two years. I think the four crops have well paid me for the trouble of trying the experiment; and the result has been, thus far, quite as good as though I had applied thirty loads of manure to the land. The soil was clayey; the earth applied was a yellow loam. I think the mixing of soils, as clay upon sand, or sand upon clay, will prove of great benefit where the materials for making an abundance of manure are scarce."

272. I have known other instances in which farmers have kept their teams hauling earth from hills, knolls, or places where excavations were being made, to fields on their farms—some times more than half a mile distant—where the soil was of a different quality from that which they were hauling; and the good effect could always be perceived in the increased productiveness of such soil for any crops that were raised on it for several years to come.

MIXING SOILS IN NEW YORK.

273. In addition to my own experience, which has been recorded in other places in this book, I copy a few paragraphs from the *Country Gentleman* concerning mixing soils: "Draining and manuring are the principal means which have *hitherto* been employed for improving the condition or composition of soils. Almost all agriculturists—certainly all inquiring and well-informed ones—are now pretty well acquainted with the advantages to be derived from the above-named methods of improvement, and are thoroughly convinced that all injudicious expenditure, either in the way of draining or of manuring, will or may be made to pay. The agricultural community do not need great addition to their knowledge on these points. But there is a method of improving soils, to which the attention of farmers

has not been, as yet, much directed. We refer to that method which consists in adding to soils those *earthy* substances in which they are deficient. Some little has been done in this way in the case of gardens; but in the case of fields or plow-lands, very little has been attempted, principally, we presume, from the generally prevailing opinion that labor expended in this manner 'will not pay.'

274. "This opinion we are inclined to think an erroneous one in many cases. Where labor is scarce and high it may be true; but where there are quite a number of boys in the family, and several teams on the farm, and work not crowding in the fall and early part of winter, we think this opinion may stand in the way of making some additions to the too sandy, too clayey, too mucky, or too something else soil of a field, which would render that field much more productive, causing an increase in the crops from it for many years, which would amount to a large percentage on the cash value of the labor expended on it. From what we have witnessed in the case of some gardens and some patches for corn-culture, to which sand, meadow muck, and composts of various kinds had been added so as to alter the composition of the soil very much—as, for example, changing a hard clay, almost all the season too stiff to be worked with hoe or otherwise into a loose, friable, dark-colored loam—we are strongly inclined to the opinion that a large outlay in making needed alterations in the composition of soils would be better than investing the money at an interest of 10 per cent. As small experiments of this kind, comparing the outlay with the increase of products as far as that can be done, would be the most likely way of banishing erroneous opinions, and of leading to the general prevalence of right ones, we would urge those who can spare the time and labor at any time from this date till the setting in of winter, to make a trial on some small patch of garden, meadow, or corn ground. Let clay, clay marl, sand, gravel, meadow muck, &c., be drawn out upon the soils which need such additions; let these additions be spread equally over the surface in the spring, and the results carefully noted. These results will not consist wholly in

increased productiveness of soil, but there will be, besides an increase of crop, a greater facility and pleasure in cultivation, an opportunity of raising crops for which the soil was formerly unsuitable, and, probably, a more obvious and ready return from the application of manure. Light sandy and gravelly soils, upon which, perhaps, wheat cannot be raised to any advantage, are benefitted by additions of clay, clay marl, peaty earth or meadow muck, or a mixture of all of these in a compost with stable and barn manure. Clay soils, again, are benefitted by additions of lime, sand, gravel, loamy sand, and peaty earth. Any of these separately, or a mixture of several of them, will alter for the better the composition of such soils, and render them more friable, fertile, and easily cultivated. Upon both these kinds of soil, and indeed upon almost every variety of soil, peat earth acts favorably. It should always form a part of any mixture which is added to a soil if it can be had conveniently.

EXPERIMENTS IN MIXING SOILS.

275. To these general directions I will add a brief account of two experiments of the kind I am recommending, which have fallen under my observation, and from the details of which a hint or two may be gleaned for the guidance of those who are disposed to continue experimenting on this subject. In the first case, the spot most convenient for a garden on a new farm was one of hard, stiff clay. An attempt was made during the first year to make the soil of this garden more friable and loose by plowing in a liberal supply of long or undecomposed manure. This, however, seemed to have little effect. Next year leached ashes were spread freely upon a part of this clay garden, perhaps two inches deep, but with little effect in making the soil looser, or more capable of being hoed in warm dry weather. During the fall or early winter of another year enough of meadow muck was drawn upon the garden to cover the whole surface to the depth of about two inches. This was intimately mixed with the clay to the depth of 8 or 9 inches the first year, by spading, raking, &c., and from that time to this that soil has had quite a

different appearance, has been much more productive, never gets baked, compact or hard, and admits of the weeds being pulled up with much more ease than formerly. In the other case, there was a peaty meadow and much clay soil upon the farm. Near by, however, was a sand hill, from which could be taken any quantity of pretty fine and pure sand. In the fall of each year, for a term of years, enough of sand was drawn from this hill to cover a large barn-yard to the depth of 5 or 6 inches. This was spread out evenly with the hoe so as to be a bed for the cattle. Being fed around this yard, and sleeping in it at night, almost all the droppings of the cattle and all the urine fell upon this sandy bed of the yard. When the surface became filthy, so that the cattle could not readily find a clean place to lie down, the plow was taken out and run through this sand, and a new, fresh, clean surface turned up. Such was the mode of management during the winter. In the spring, at convenient times, this sand was all hauled out upon the farm, sometimes upon the low meadow, but generally on the upland. From cart or wagon two men scattered it as far as it would go. The natural meadow became gradually less mucky, and more fit for the growth of herds' grass, and subsequently of crops of corn. The clay land became more loose and friable, and when the dressing did not extend all over the field to which it was applied, the difference in the color and growth of the grass, and in the amount of the hay, was quite observable. One field which had more of this dressing than any other became changed from a stiff, compact clay to a loose, friable clayey loam; and with a dressing of meadow muck from the cleanings of the ditches, assumed a dark appearance resembling those rich low soils which abound in carbonaceous deposits. These fields can now be plowed or hoed at times when, as formerly, they would have been hard and compact almost as a brick.

IMPROVING SANDY SOILS WITH CLAY.

276. A correspondent of the *Germantown Telegraph* writes: "There is a very erroneous impression on some minds, that light, loose sands are valueless for the purposes of cultivation. In

their natural state, it is true, they are not very productive. A few crops of rye or buckwheat reduces their fertility, and so much manure is thenceforth requisite to reinvigorate and keep them in heart that they are either turned out to pasture or abandoned in despair. I have had some experience in the cultivation of this species of soils; and my success has induced me to attach to them a much higher degree of importance than is usually accorded. And I am fully persuaded, that even the lightest and most sterile soils may, by proper management, and without any ruinous outlay of expense, either in time or capital, be made highly and permanently productive; in short, that our poorest plain land can be redeemed from this unjust imputation of utter worthlessness, and made to yield not only remunerating crops, but crops equalling in abundance and richness those afforded by the most affluent soils upon which labor was ever yet bestowed. In the first place, in order to the successful amelioration of sandy soils, it will be necessary completely and thoroughly to cleanse them from stumps. After this is effected, let them be ploughed deeply with a strong team in the last of summer, turning in all the growth upon them to the depth of at least one foot; then harrow thoroughly and roll with as heavy a roller as you can procure. The next thing is to give the surface a good dressing of clay. This earth will generally be found in the near vicinity of the field to be clayed, either in some neighboring run or water course, or beneath the sand; for sand and clay are never far apart. The finer it is, and the more *greasy*, the better and more durable will be its action; and the more liberally it is applied, the more thorough will be the improvement consequent upon its application. The best time for applying it is immediately after ploughing; and, to secure its being refined and broken up, it should be deposited in heaps, and spread evenly over the surface, to remain exposed during the winter to the action of the frost. In the spring plough again, not so deeply as before. In order not to disturb the sward, harrow, and again roll. You can now sow on rye, or plant; and the crop will come off in season to allow you an opportunity to give another dressing of clay, which in quantity should be

equal to the first—say forty cords to the acre—and spread as before.

277. This will entirely change the texture of the soil, and you will no longer have the barrenness of sand to contend with; but a soil endued with all the essential requisites of permanent and vigorous fertility, and on which manure will act with as much celerity and energy as upon the richest loams. It may be thought that the quantity of clay recommended—80 cords to the acre—is large; but when we reflect that some cultivators bestow this amount of stable manure, and bear in mind the important fact, that while manure is an article for which money has to be paid, the whole cost of clay is embraced in the carting, the objection arising from the quantity requisite to insure a complete and thorough improvement being large, will at once cease to retain its force. If the farmer cannot afford this, he can apply a less quantity at first, and add to it year by year; but, in this case, he must contend with a much less lucrative return for his annual labors, as a very large per centage of clay is called for, in order thoroughly to improve the soil, and overcome the many and serious imperfections of sand, as it naturally exists. Therefore it is much better and more in accordance with a policy of enlightened economy to give enough at first to effect the object desired, than to occupy years with only a limited annual return.

278. One great reason—and indeed I regard it as the principal one—why manure never acts vigorously on light sand is, that the extreme porosity which characterizes it, causes the dung to keep *dry*, and consequently to remain *inert*. A lump of dry manure is no better in the soil than a chip or a stone; and will produce just the same effect upon the crop. The clay gives cohesiveness to the particles, unites them, by a sort of glutinous attachment and consolidation. And while it favors absorption and retention of moisture, insures the fermentation and ultimate decomposition of the dung. In a few years the soil assumes a fine dark appearance, resembling that of garden mould; and the various grasses will find in it a bed capable of affording expansion and soluble food commensurate with their wants. To every

person, therefore, who is the possessor of sandy soil, I would say *clay it at once!* No soil is so easily worked; and from no soil, when managed in this way, will labor secure to itself a more certain and rich reward."

LASTING EFFECT OF CLAY WITH SAND.

279. Judge BUEL, who gave such an excellent impetus to practical agriculture in America, on the sandy soils near Albany, N. Y., penned the following remarks, which will be read with interest: "A few years since I broke up and planted to corn a clover lay upon sandy soil, embracing an area of about ten acres of land. Upon an acre of this ground, more than twenty years before, thirty loads of clay had been deposited, and had become thoroughly incorporated with the sand. The ground in every other respect possessed the same character and qualities. It was plowed at the same time and subjected to the same tillage in every detail. Immediately on the appearance of the young sprouts, the crop growing upon the mixture of sand and clay exhibited a more vigorous growth, with a deeper and healthier color. As the crop advanced, the difference increased, and the boundary of the area became as distinctly marked by the appearance of the crop as if it had been separated by a hedge from the remainder of the lot. This appearance was so remarkable as to attract the constant observation and inquiry of strangers as to the causes of the marked and peculiar distinction. The part of the lot containing the clay was little injured by the grub and worms, although the remainder suffered severely from their ravages. The crop of the entire field was excellent; but that grown upon the acre of clayey sand yielded almost twice the harvest in both grain and stalks of any other acre."

280. The result of an experiment is recorded in the *Genesee Farmer*, which the writer states was tried in Herkimer County, N. Y., from which it appears that the hygrometrical or absorption power of a loose, sandy soil treated with a light coating of clay was very efficacious. The author says that, during a trying drought, a poor, sandy soil that he had treated with a coating

of blue clay the year before, now stood the drought well, yielding a good crop of red clover, while the other part of the field, unclayed, remained parched and dry, presenting a scanty vegetation, hardly worth harvesting.

281. Again, the soil thus clayed was so permanently benefitted, that it required less than half the stall manure to enable it to produce crops that was required by the sandy surface not thus treated with clay; thus proving that the constant requirement of sandy soil for heavy manuring is entirely due to its lack of the aluminous principle which enables it to hold the escaping gasses of decomposing manures for the benefit of the growing crop. There are thousands of acres of scrub oak and pine plains on Long Island, within two hours by rail of the city of New York, all *arable land, needing no underdrains*, a sandy loam surface and coarser subsoil; but making a compact and perfect race-course roadway. To grow the best of red clover, these plains have only to be cleared and burned over, but for continuous cropping, the soil needs the aluminous principle in a coating of clay, which when worked in gives adhesive absorptiveness to the soil, without which there can be no lasting fertility short of continued heavy manuring.

282. THAER says, in his *Principles of Agriculture*, that "Land should be chiefly valued according to its consistence; the greater the degree of this quality which it possesses, the nearer does it approach to first-class land; but the smaller the proportion of clay, and the larger quantity of sand which enters into its composition, the more rapidly does it fall in value." Experience as well as history confirms this remark as correct. All the great deserts of the world are composed mainly of shifting sands. The most fertile soils, wherever found, contain a large portion of clay. Clays, however, differ largely in agricultural value, as may hereafter be shown.

283. One reason for the valuable character of clay soils is found in the fact that they contain, more than any other soil, the elements of fertility within themselves. They are usually more or less productive, if rightly cultivated, without aid from stimulants

or manures, but acknowledge such aid very gratefully when received. A recent writer says "they are deposits of various earthy compounds mixed in many cases with organic matter, and frequently require only aeration to render them productive."

284. The practical lesson taught us is, that to farm clay soils profitably we must take full advantage of the property they possess of attracting and holding the elements of fertility supplied by atmospheric influences—air, water and light. To this end they must have exposure to the air, freedom from stagnant water, and a course of tillage which shall keep them in a comparatively mellow state. The natural characteristic of clay is to attract and retain water, to harden in drying, and to become impervious generally to all ameliorating influences, and the more so the longer they remain undisturbed. This, however, depends more upon their state of *drainage* than upon anything else; and this naturally accords with the amount of clay present in the soil, and the porous or non-porous character of the subsoil.

CULTURE OF HARD-BAKED SOILS.

285 On this subject, I transcribe some remarks that were prepared for the *Country Gentleman*, adding such as more mature experience appears to warrant. To produce a proper seed-bed on a heavy or hard-baked soil is always a difficult matter, requiring a great amount of labor, and often resulting imperfectly at last. If land containing a certain proportion of clay be plowed in the usual manner, comparatively *dry*, it will present a greater or less proportion of lumps or clods of a size proportioned to the depth of the furrow and the baked state of the soil, and very far from affording a seed-bed likely to produce any profitable crop. If plowed when comparatively *wet*, and dry weather follows before any further cultivation ensues, the same cloddy state is the result; nor would the preparation of the soil be enhanced by any working given, while the soil was in a plastic state. To produce the best results in the easiest way, such soils must be worked when *just dry enough to crumble down;* when not so wet as to knead, nor so baked as to require great force to break

it up, and only in clods at that. We find it difficult to explain the matter plainly; but every farmer who has uncultivated heavy soils will understand our meaning from his own experience. The question, then, is not when and how shall we best cultivate heavy soils; but how, when a heavy soil becomes baked, shall it best be pulverized—best reduced to that state of fine tilth to furnish a proper seed-bed for our crops. We cannot always take advantage of that crumbling stage of a heavy soil; our forces may be otherwise employed, or insufficient to do all our plowing while the ground is properly moist. Therefore the great idea will be to reduce these huge slabs of putty-like furrow slices, or the rough clods and lumps, to a fine tilth.

286. In the first place the soil must be thoroughly drained. If it is wet and continues to remain wet, until the scorching heat of summer has dried up the excessive moisture, there is no possible way of accomplishing this important object but by mechanical means. When these compact soils are covered with lumps of baked earth, a few hours after a heavy shower of rain has fallen, they will crumble to fine powder at a slight pressure. *Therefore let a heavy roller pass over them, which will pulverize,* most thoroughly, every one near the surface. (See How to Make a Good and Cheap Roller in Vol. I.) After the ground has been rolled, harrow it, with a heavy harrow. This will pulverize many of the lumps; and will also bring many more to the surface, which must be crushed with the roller. (Read When to Harrow Compact Soils in next Chapter.) But in case the soil was plowed when so wet that it lies in long, hard furrow slices, just as the plow left it, the best way will be to cross plow it when it is just dry enough to pulverize well. After this, apply the roller and harrow shortly after a heavy shower of rain; and the work will be done.

KEEPING STOCK OFF SOILS WHEN WET

287. Few farmers, comparatively, appear to exercise that great care on this point which is absolutely necessary in order to keep heavy soils from plowing up lumpy. When the soil is frozen

up tight, or is dry, stock cannot injure it by running over it. And many farmers will insist that it will not make it lumpy to allow stock to tread and poach it in the fall; because they insist that the frosts of winter will expand and pulverize it wherever the feet of stock may have poached it, although a soil will not plow up as lumpy when it has been poached in the fall by the feet of heavy stock as it will if they are allowed to run over it in the spring; still that soil will be far more lumpy when cattle have poached it in the fall than it would be had it not been poached at all.

288. Wherever heavy animals are allowed to poach a soil that will bake hard in dry weather, their feet compress the dirt into less than half the space that it occupied previous to being poached. And such portions must be expanded more than half a dozen times before it will occupy as much space as it did before being compressed. And when a soil is already too close and compact, it will be very injurious to it to have it pressed into half the space that it ought to occupy.

289. My own practice always was to exercise as much care in keeping heavy stock off plow lands, when the soil was wet—at all seasons of the year—as I did in keeping them off my fields of grain or meadows. Where there is a large proportion of sand or gravel in the soil, heavy animals will not injure it by poaching as they will a clayey soil. But there are few soils in America that will not be injured, more or less, by being poached by heavy animals when they are too wet to be plowed.

RENOVATING WORN-OUT LANDS IN MAINE.

290. On this subject E. L. HAMMOND says: "The renovation of an exhausted farm requires time, patience, perseverance and capital; and the larger stock a man has of these on hand, the sooner he may consummate his object. Yet patience and perseverance will accomplish much in a short time, if rightly applied. Any mode of farming which does not return to the farm annually that amount of plant-sustaining elements which have been drawn from it by the crops which have been removed, may

be set down as bad management, and will soon show itself in the shape of a worn-out soil."

291. It is sometimes found that apparently worn-out soils are not so much exhausted as they appear to be; and by a right application of means they may be easily reclaimed. I think that a large majority of farms, at least in the northern counties of Maine, are of this class. For instance: a succession of the same kind of crops may have exhausted the soil of more or less of the elements necessary to sustain and nurture such crops, and still retain the necessary elements to grow some other. Again, a variety of crops may have exhausted the surface soil of most of its plant-sustaining properties, where shoal plowing has been the practice, and the farmer considers his farm worn out, when, if he would deepen the cultivation a few inches, he would probably turn up to the action of the air and water many important elements necessary to sustain vegetation.

ADAPTING CROPS TO THE SOIL.

"Each soil hath no liking of every grain,
Nor barley nor wheat is for every vein;
Yet know I no country so barren of soil,
But some kind of corn may be gotten with toil."—TUSSER.

292. After all our discussion about the various kinds of soil, and the different modes of managing them, in order to make them fertile and productive, if a farmer fails to adapt his crops to the soil, he makes a grand failure in the one great and essential point on which all his success depends. Why can we not raise water melons and musk melons, by the wagon load, on our best wheat soil, as they are raised in many places on a different kind of soil? Because the soil is not adapted to their growth. On the contrary, why can we not grow forty bushels of good wheat per acre on the very soil where melons, squashes, and sweet potatoes will attain an enormous size with almost no cultivation at all? Simply because the soil is not adapted to its growth.

293. Multitudes of farmers, not understanding this principle, have expended, in the aggregate, small fortunes in trying to grow

certain crops on certain soils, which were no better adapted to each other than our northern winters are to the necessities of the chattering wren. Thousands who were ignorant of the constitution of a good soil for wheat have read the cheering accounts of raising forty or more bushels of wheat per acre in certain localities; and thinking that manure, clover, and thorough pulverization of the soil were the all-important considerations for wheat, they have plowed deep and manured highly some fields where hardly a trace of clay could be found, and have produced straw large enough to yield more than fifty bushels of grain per acre, but received, to their great disappointment, hardly enough to pay the expense of cultivation.

294. Now, what has been the result? Why, those who have failed to grow as large a crop of wheat on a soil that was not at all adapted to that kind of grain as another farmer produced on the best kind of a wheat soil, have lost their confidence in reports of such agriculture, and denounced it as "humbuggery," as "book-farming," and as a report concerning something that "no practical farmer ever realized." And thus it has been in multitudes of instances concerning root crops and grass. Some farmers have taken a new start in agriculture to raise roots of some kind—beets, carrots, or turnips—for feeding stock, and have selected a piece of ground that was no more adapted to the production of such crops than the clay of a brick-yard is adapted to making a good radish bed. Of course, after bestowing twice as much labor in their cultivation as they require in a good soil, they were compelled to acknowledge a failure, and were glad to return to a proper system.

295. Here, also, is another cause of failure. We may go through our States, from Maine to Kansas, inquiring about grasses for hay and for grazing, and we shall find a large proportion of our best farmers cultivating and ready to extol, in the highest terms, certain kinds of grass, while nearly an equal number will denounce those very kinds as not fit for cultivation. Let a man read all the communications in our best agricultural papers concerning Hungarian grass—for example—and if he possesses no

other evidence of its excellence, he will be as much puzzled to decide upon its merits as he would be were he required to determine correctly the points of the compass in a cloudy day in the middle of the ocean. (See the details of this subject in the Chapter on Grasses and Wheat.) The correct way is for every farmer to ascertain, by trial and careful observation, what kinds of crops a soil will produce most advantageously, and then adopt a short rotation of such crops as will succeed well.

UNPRODUCTIVE SOILS.

296. The unproductiveness of soils is attributable to various causes. Sometimes it arises from excess of water, sometimes from a deficiency of water, sometimes from a want of lime, humus, or vegetable matter, and frequently from growing exhausting crops for many years in succession without employing any fertilizing material for the purpose of maintaining its fertility. In the majority of instances, however, the soils of our country are rendered unproductive by an excess of water, and by growing exhausting crops on them for many years without applying any manure. In some instances the soil appears to be naturally unproductive, and neither too wet nor too dry, nor deficient in lime or vegetable matter; and sometimes an excess of some acid, alkali, or iron is the true cause of unproductiveness. Soils that are composed, for the most part, of coarse gravel and sand are quite too porous to retain a sufficiency of moisture and vegetable nourishment near the surface of the ground, where it is essential to the growth of plants when the seed first germinates. Heavy clay soils are sometimes unproductive from a want of thorough pulverization. This is a common cause in many localities where the ground is plowed very shallow, with wide furrow slices, and only once a year, very early in the spring. Many times the elements of fertility are held so firmly, both mechanically and chemically, in heavy soils, that their unproductiveness will yield only to the combined influence of mechanical action in pulverization and chemical influence arising from the application of lime, gypsum, or something else, that will destroy this combination

and firmness, and render the elements of fertility available by plants. It is proper that we keep in mind the difference between soils that have been rendered unproductive by injudicious management and those that are naturally sterile or unproductive from some one or more of the causes just mentioned, as it is of great importance to know why a soil is unproductive before the best means can be employed to restore its impaired fertility.

MANAGEMENT OF DIFFERENT SOILS.

297. The reader has, doubtless, perceived through this entire book that I have been particular to state *the kind of soils* when allusion is made to a given system of management, because I consider this a very essential point in plowing, harrowing, manuring, and almost everything else connected with its cultivation. I have been more accustomed to the cultivation of heavy soils than light soils. Consequently, when I give the details of my system of managing for almost any kind of crop, those farmers who have never cultivated a heavy soil laugh me in the face, and set down such directions as palpable absurdities. The truth is, they know nothing about the most proper manner of cultivating heavy soils. On the contrary, let us talk to a man who is entirely ignorant of the best manner of cultivating a *light* soil, of the manner of plowing, harrowing, and fertilizing, and he is ready at once to denounce such a practice as superlatively ridiculous! Let us, for example, refer to the cultivation of different kinds of roots. A good farmer of New Jersey, or of some parts of New England, whose soil is very light, fertile, and never apt to bake, raises vast quantities of roots of almost any kind. He has only to scatter the seed, and brush it in a little, and keep most of the weeds subdued, and he raises a bountiful crop; and it appears a mystery to him that farmers in other localities do not grow more roots when they can be produced at such a small expense. Only one plowing, and half done at that, and he is certain of a crop. But, on a heavy soil, one must ditch and plow in autumn, and subsoil, and harrow, and roll, and harrow again and roll, and wait sometimes a week or more before it will pos-

sibly be dry enough to plow or harrow; and, when it is just right to pulverize well, to drive the teams early and late in order to take advantage of the best time for pulverizing the soil most effectually. All this discussion about pulverization and plowing and harrowing in the right time is downright nonsense to the farmer who has never worked heavy soils. For this reason, I have endeavored to make a marked distinction in the system of managing both light and heavy soils for nearly all kinds of crops. And every good farmer will coincide most perfectly with the suggestions and directions. It should always be kept in mind that different soils will require different systems of management.

HOW TO RENOVATE BARREN SOILS.

"The soil must be renewed, which, often washed,
Loses its treasure of salubrious salts,
And disappoints the crops."—COWPER.

298. In many parts of the country soils are found naturally so sterile that it is difficult to grow even a small crop of any kind of grain or grass. When there are no beds of muck or peat within convenient hauling distance, and no foreign manure is used, it is a tedious task to render such a soil even moderately productive. Still, it can often be done with no other fertilizing material than the farm affords. Take, for example, a shallow calcareous or silicious loam, in which there is little or no humus or vegetable mould, and which has never produced much except weeds. Soils of this description can seldom be benefitted by underdraining, because the subsoil is usually so porous that the large amount of water falling in the spring and autumn leaches through the soil in a short time. If there is surface water in certain places, of course the first step will be to render it dry by thorough draining. The next operation will be to obtain a little mould, or humus, of which such soils are destitute. If barn-yard manure, mellow earth from the highways or pond beds can be obtained; a thin layer over the surface will enable a farmer to bring a sterile soil into a good state of productiveness in a few years. Where nothing of the kind is at hand, proceed as follows;

Plow in autumn if possible, not more than six inches deep, and plow again in the spring no deeper than before, as soon as the frost is out and it is sufficiently dry. The surface soil is superior to that which is seven or eight inches below, even where it is very sterile; and it is important to keep the best on the surface. As soon as the ground is sufficiently warm to plant Indian corn, *plow again in narrow furrow slices, and sow broadcast*, or drill in, three and a half or four bushels of good grain per acre. It is better to drill in two bushels per acre each way than to sow it broadcast, as it will be covered of a more uniform depth, and will grow more uniformly. Now, sow three or four bushels of gypsum per acre, and the more wood ashes the better, even to one hundred bushels per acre. If the work be well done, and the soil unusually sterile, all that can be expected will be a growth of green corn, from one to two feet high. As soon as the tassels have appeared, which will be in about seventy days, plow it under, sow five to ten bushels of quick-lime, and harrow it in; then drill in another four bushels of corn per acre to plow under just before frost. By this means two coats of green manure will be plowed under, which will furnish more humus or vegetable mould than any other plants will supply in one season. The spring following, plow with narrow furrow slices, as soon as the soil is dry, but no deeper than usual, sow five or eight bushels of quick lime per acre, harrow it in, and drill in one bushel of spring rye per acre. Then sow eight pounds of early red clover seed and half a bushel, or seven pounds, of orchard grass seed per acre. If the ground be at all lumpy, roll it before sowing the grass seed. As soon as the rye has come up sow two or three bushels of gypsum per acre. The chief object of the rye is to shade the young grass, should there be much hot weather. As soon as the rye begins to head, mow it all off with grass scythes, a foot or more high, letting it remain where it falls. If the rye be allowed to go to seed it will exhaust the fertility of the soil. Keep all stock off the grass that it may become well rooted. Should it attain a large growth by autumn, it may be fed off in part; but in general it is best not to do so.

299. The next spring sow three or four bushels of gypsum per acre, and all the wood ashes leached or unleached that can be obtained, unless previously applied. If the grass be grazed off, it should not be fed very close to the ground. It is better to mow it, make hay, feed it to sheep or neat cattle, and return the manure as a top-dressing for two years. Then plow the usual depth with a common plow, following with the subsoil plow, and plant Indian corn one season, sow peas the next, and feed out most or all the crops to swine, sheep, or neat cattle, and make as much manure as practicable to return to the soil. The next season, if the soil be adapted to wheat, winter wheat may be sowed after peas, and the ground stocked down in autumn with timothy and the late kind of red clover; the next spring there will be a sufficient quantity of mould in the soil to commence a system of rotation of crops. The best soil should be kept near the surface. It would be bad management to plow such soil deep with a common plow, though the subsoil plow may, in very many instances, be used to advantage.

RENOVATING FARMS THAT HAVE BEEN IMPOVERISHED BY INJUDICIOUS MANAGEMENT.

300. This desirable object must be accomplished mainly by barn-yard manure, by grass, and by allowing the soil to rest. There are scores of once good farms, almost everywhere, that have been so impoverished by a long succession of exhausting crops that they will no longer return to the owner the expense of cultivation. In most instances such farms can be restored to their original fertility, if a correct system of management be adopted, in a few seasons, because they have been, as a general rule, too wet to produce large crops; and the proprietors have been so anxious to skim over a great number of acres that they could not, or have not, plowed deep, and therefore the fertility of the soil has not been so much exhausted as if it had been well drained and plowed deep. If the crops have all been carried off on some adjoining farm, the case is far worse than if they have been consumed on the farm, and large quantities of manure are lying

about the farm or in the barn-yard. When a farm is greatly impoverished, and there are no heaps of manure, and nothing at hand to make manure of, the task and expense of bringing the soil to a degree of ordinary fertility will be attended with increased labor and expense, and a greater length of time. But it can be accomplished in due time by perseverance in a wise system of management.

IMPORTANCE OF DRAINING.

301. The first step, then, in renovating an impoverished soil will be to drain the wet places; and, if the soil needs it, to go into a judicious system of *thorough draining* by cutting ditches parallel to each other, a given distance apart, over the entire farm. Thorough draining will lengthen the growing seasons in localities where there is an excess of water; and wet land that has been well drained will not require half as much manure of any kind to produce large crops as would be required without draining. Indeed, in many instances where land has been drained thoroughly, it will produce twice as much grass, or any kind of grain, *without manure*, as some other portions of the same field will with a good supply of fertilizers yearly, and twice as much more as that very soil has been wont to produce before it was drained. This proved true on my own farm; the low places, in every field which had been well drained, would usually produce twice as much of any kind of crops as the higher and drier portions, which received, every few years, a bountiful coating of manure. Draining all the wet places on a farm, and adopting a judicious system of thorough draining, is the very first step towards renovating an impoverished farm. All the manure in the kingdom of nature will not produce a large crop where the soil is thoroughly water-soaked and sodden, so that it rolls up, when plowed, more like a furrow of putty than a productive soil.

COMPLETE PULVERIZATION OF THE SOIL.

302. The second step is *thorough pulverization*. This must be accomplished, for the most part, with the common plow.

Mines of untold wealth lie slumbering beneath the impoverished soil, and it must be turned up in small quantities every season, and mingled with the soil, thoroughly pulverized. The soil must be plowed in a most thorough and farmerlike manner. It will not answer the contract to set a little, inexperienced boy to plowing with a yoke of weak, poverty-stricken, straw-fed oxen, or with a span of poor, ring-boned, chest-foundered, broken-winded horses, with some old worn-out plow. By no means. But a good plow is essential, and a strong and well-fed team, that will be able to move along steadily, and turn a deep furrow. (*Read more about Thorough Pulverization of Soils in the next Chapter.*)

WAY TO IMPROVE PASTURES.

303. The true way to improve a pasture is to plow it, and cultivate the soil for a few years, and apply a liberal dressing of barn-yard manure, or turn under a crop of red clover, and then sow about three or four bushels of Indian corn per acre, as soon as the clover has been plowed under, and turn that under before frost injures it; and then sow the ground with winter rye so late in the fall that it will not vegetate before the next spring, when the soil should be well seeded with three or four different kinds of grass seed which are adapted to the soil and to the locality.

304. In case there is an excess of water in the soil, the first operation should always be to render it dry, by underdraining the wet portions of the field; or by adopting a system of thorough draining—making drains about two rods apart, over the entire field. Very many fields require such a system of draining before they will produce as much good pasture as they are capable of producing. And every intelligent farmer knows that a bountiful crop of tender and sweet grass cannot be raised on a soil that is inclined to be wet. It is true that a tolerably fair crop of some kinds of grass may be raised where there is an excess of moisture; but by draining that same soil, and by bringing it into a better state of fertility by thorough pulverization and more or less manure, the quantity of grass may easily be doubled, and the quality very greatly improved.

305. In many parts of New England there are many acres of pasture which it is very desirable to improve without plowing the soil. These fields have been in grass for many successive years. And in many instances they have become "turf-bound," as it is termed, which means that there is a thin mat of old, tough, dried-up roots and moss on the surface, which obstructs very much the luxuriant growth of young and tender grass. Such fields cannot be rendered productive, to their highest capability, without inverting that tough sod, and bringing a new soil to the *surface, thus starting* a new system of roots and a new turf. But it may be very greatly improved in productiveness. Therefore the

WAY TO IMPROVE PASTURES WITHOUT PLOWING

will be to top-dress the soil with fertilizers of some kind, and then give the surface a thorough harrowing, with the harrow teeth well sharpened.

306. The character of the soil will be a good guide, in a measure, for determining what kind of fertilizers may be employed most economically. On many of the sandy loams and silicious sands of New England there will be nothing superior to a dressing of ground bone, harrowed into the soil in autumn. In case the soil were not well turfed over, it would be better to defer the harrowing till spring. Then, after harrowing well, sow a few pounds of white clover seed, a few pounds of timothy, a few pounds of orchard grass seed, and a few pounds of Kentucky blue-grass seed, mingled together, making in the aggregate from four to six quarts of seed per acre. Perhaps red clover might take the place of some other seed. But the chief idea is to seed the land well with a kind of grass seed that will flourish well in that particular locality. In case ground bone be applied, it will be better to sow it before the soil has been harrowed, for the purpose of covering it slightly with earth, as a little moisture and heat will hasten the decomposition of the small fragments of bone; and the little roots will twine around these small particles, and absorb them as fast as the rain and heat will dissolve them.

On some soils, ten or twenty bushels of lime per acre will be the best top-dressing that can be applied after harrowing and re-seeding with grass seed. A few bushels of gypsum, also, mingled with wood ashes, will be a good dressing. In case, however, a farmer has a good quantity of barn-yard compost, well rotted, the most economical way will be to spread it evenly, late in autumn, and harrow it well in. Then, the next spring, sow grass seed of several different kinds, and harrow again.

307. This system of management will usually insure a good crop of grass. But pastures treated in this manner should not be fed off until the middle of summer, or until the young grass is well rooted. And, sometimes, not a hoof should be allowed to go on the ground until autumn. If sheep or cattle be permitted to graze on such fields, just as the young grass begins to grow, their sharp teeth and hoofs will destroy it faster than it can grow. The grand reason why there are so many poor pasture fields in our country is, the grass is fed off too closely when it is very small.

HOW GRASS LAND IS IMPOVERISHED, AND HOW IMPROVED.

308. Chemists tell us, that in a ton of good hay there are one hundred and fifty pounds of mineral matter and twenty-five pounds of nitrogen, equivalent to forty six and a half pounds of ammonia, which is of great value in promoting the growth of grass or of any other crop. This mineral matter alluded to is composed of forty-three pounds of potash, twenty-five pounds of lime, and eight and a half pounds of phosphoric acid, besides several other ingredients not enumerated. Now, as these elements become scarce in the soil, the quantity of a crop will be diminished, unless special care be exercised to return to the soil an equivalent for the amount that has been carried away in the hay. The question naturally arises then, *how* can this be done in the most economical manner, so as to maintain the fertility of the soil? There are several ways of doing it. But the farmer needs to understand the most *economical* way of performing a task so important and desirable. One of these ways is, to supply the waste

by scattering ashes, lime, bone dust and gypsum over the meadow after every crop of hay has been removed. In this manner a meadow may be made to yield a heavy crop of grass every season for a long time. The ashes will furnish the necessary potash, as that ingredient promotes the growth of grass very much, as may be proved by observing the rank and luxuriant growth of timothy or clover in the bed of a log heap, or where brush has been burned. A top dressing of bones and lime will supply the other ingredients that have been removed in the hay. Another way of maintaining the fertility of grass land is, by the application of guano or superphosphates, which contain all the elements of fertility which are necessary to secure a heavy crop of grass. These two ways are rather expensive modes of maintaining the fertility of grass land; but when the grass is all removed from the farm, either in a green state or in hay, one or the other must be resorted to, unless the proprietor has access to peat, marl, or a stable manure. Still another way of maintaining the fertility of grass land is by barn-yard manure and home-made compost. This is the most economical, and in fact the true way for farmers in general to keep their meadows and pastures in a good state of productiveness. By saving with care all the manure that can be made from animals while they are consuming a ton of hay; by mingling a little muck with the manure, and by feeding some grain and oil meal, and applying the manure judiciously, the quantity of grass per acre may be increased a little from year to year, for years to come.

MANAGEMENT OF PASTURE LANDS ON DAIRY FARMS.

309. The management of pasture lands on dairy farms will be different with unlike soils. Broken and uneven surfaces, hard to be tilled—hill-sides, where the surface lies near the rock—thin or sandy soils—it is evident must be studied as to their character, and treated according to the peculiar circumstances or difficulties that may surround each. Lands natural to grass—and these embrace a greater portion of the clays and shales—produce pasturage, year after year continuously, if properly attended to; and would

often be injured for pasture by plowing and reseeding. It is an erroneous impression that newly seeded meadows, producing large yields of one or two kinds of grass for hay, would, if turned to pasturage, be equal to good old pastures for grazing milch cows.

310. When pastures fail and become foul, and the grass scanty and poor, they need breaking up; and will be vastly improved by thorough cultivation. But the practice common with some, of breaking up large fields of good clean, sweet sod, which perhaps may have been a trifle injured by the too close cropping for a season, in order to raise grain for a few years, and frequently, too, without the application of manures, is believed to be pernicious on dairy farms.

311. We have seen rich, old pastures, solid in growth and yielding largely, plowed up for the reason that a good crop of corn was wanted, and *that* particular field seemed best suited to the purpose. It did produce good grain crops; but after being got back again into grass, the annual yield was very much less than on the old turf.

312. In the treatment of old pasture lands, injured from close cropping, but not wholly run out, it will generally be better not to break up, but to leave them for a part of the season to resuscitate, running a harrow over the ground in early spring, and sowing a mixture of timothy, blue grass, red top, the clovers, red and white, and orchard grass, making an application of plaster, pulverized bones, ashes, salt, or other stimulating fetilizers. Ashes, leached or otherwise, remove mosses, and are a valuable application to grass lands.

313. There are pastures in Herkimer county, N. Y., which have not been broken for more than forty years—many that have never been ploughed perhaps but once or twice, years ago, when the country was new, that are yielding an abundance of nutritious food, enduring year after year close cropping and drought, without any perceptible injury or tendency to run out, and yet have received no top-dressings beyond the usual application from time to time of gypsum. The grass on these lands springs up green and fresh, with thick fine bottom, a marked contrast

throughout the season to occasional patches on the same soil recently re-seeded. To plow and cultivate such lands would be to destroy the original grasses; and after re-seeding, many years must intervene before the new grasses can obtain that firm possession of the soil and the enduring vigor and variety of the old sod.

BEST KINDS OF GRAIN FOR DAIRY FARMS.

314. A farmer must be so well acquainted with the character of his soil—for dairy purposes—that he may be said to know of a certainty whether it will be best to plow up a pasture field, or not. Farmers are very often deceived with reference to the productiveness of old pastures and old meadows. I have known farmers to refuse to plow up some old pasture or old meadow when it did not yield half a crop of grass, because they were such great stickers for old pastures. But after a dairy farmer has decided, deliberately and understandingly, to plow up a certain pasture or meadow, the first crop most profitable for the dairyman will be Indian corn, since the stalks, properly cured, make the best of fodder, and the whole crop can be turned to good account for stock. With the second crop, re-seed. It is believed to be poor policy for the dairyman to exhaust his land by keeping it long under the plow, and in the raising of grain before putting down to grass. It is here that great mistakes are made; for the loss sustained by running the land to obtain several successive crops, will, in the end, prove to be much greater than is commonly supposed. From this cause, often lies the secret of poor meadows and sickly pastures. The soil has been overtasked, and needs rest and nursing until it has gained heart to make ample returns. Two crops of grain, at most, are all that good management would seem to authorize to be taken in succession from the soil, if the land afterward is intended to be employed profitably in grass.

315. The great object in view will be to make permanent pasture or meadow; and thus by taking a few acres at a time, thoroughly manuring and cultivating it, the work is accomplished in that piece for years. A farm under this system may in a few

years be brought up to a high state of fertility, and easily maintained and increased in its fruitfulness without breaking in upon the main business of the dairy. This course is to be preferred to that of disposing of the stock, plowing up large portions of the farm at once, and then getting it back again to grass; for only a few acres at a time can, with economy, be properly manured; and the work will not generally be performed in that thorough manner, as when the attention is directed to a more gradual, but surer, improvement of the soil. In re-seeding some attention will be needed to have a greater variety of grasses than is commonly employed for putting down pasture and meadow lands. It has been shown that in rich old natural pastures, from twelve to twenty distinct species are found in the sod, and that the number of plants to the square foot is greater when there are several kinds intermixed. Many years ago it was considered good economy for the farmer to produce on his farm nearly every article needed to supply his wants. More recently, the tendency has been to make one or two articles leading staples in certain localities, as productive of more wealth than the mixed farming of former years.

316. Some difference of opinion exists, among dairymen, in reference to grain raising, many insisting that all the grain needed should be grown on the farm in connection with dairy farming. Our best dairymen, however, do not generally advocate the system, beyond what is necessitated from a judicious rotation of crops. Flour, therefore, and much of the grain fed to cattle, are imported from grain growing districts. Meadows and pastures that need breaking up and re-seeding from time to time will be employed in grain raising; but to break up a good pasture or meadow that is yielding well, for the purpose of "plow land," or getting a crop of grain, is believed to be poor policy. Wheat and oats, at best, are not the most profitable crops in dairy districts, and can generally be purchased cheaper than raised,

317. It will be well to have some system of rotation, adapted to the soil and farm under cultivation, thus bringing every part of the farm into grass again, at intervals of 10 or 15 years.

If five acres of sod be broken yearly, and five acres be put down to grass, ten acres will be annually under the plow; which, for one hundred acres, would give meadows of ten years' standing. Under such a system it will be seen, the land could be thoroughly cultivated and enriched, and made to produce large returns both in grain and grass.

CHAPTER III.

PLOWS AND PLOWING.

"The plowman comes, behind his smoking team!
Clear the brown path to meet the mould-boards' gleam.
Matted and dense, the tangled turf upheaves,
Mellow and dark the ridgy corn-field cleaves.
Through the moist valley, clogged with stubborn clay,
The patient plowman breaks his destined way."

318. In Vol. I. I penned a Chapter on Plows and Plowing, in which the subject was discussed artistically, or as an art, and *the reader is referred to that chapter for instructions in selecting* plows—how to adjust, how to hold, how to plow a field by commencing in the middle of it and finishing at the outside, and the technicalities in plowing. But in this chapter the subject will be discussed scientifically, or with reference to its importance, and its effects on the crops that the soil produces.

319. Plowing is a mechanical operation, or, in other words, it is the act of effecting a change in the mechanical condition of the soil. (See the difference between Mechanical and Chemical stated, Paragraph 2, Chapter I.) Plowing, spading, harrowing, rolling, and pulverizing the soil in any way, by means of tools and implements, is the act of preparing it, mechanically, for the chemical changes and operations that must occur in the formation and production of plants. A farmer, with his teams and implements of husbandry, is required to perform the mechanical part of raising crops, and of making beef, mutton, pork, and wool; and nature performs the chemical part. And just in pro-

portion to the thoroughness of the manner in which the mechanical part has been performed, will nature perform the chemical part. A farmer cannot do the chemical part of raising crops, if he were disposed to attempt it. And nature will not perform the mechanical part of plowing and sowing, and reaping and mowing.

WHY DO WE PLOW ?

320. Were we to interrogate a thousand farmers, "Why do we plow ?" the answer would probably be, "For the purpose of rendering the soil more mellow and porous." This is correct as far as it goes; but the chief object is, to reduce the soil to its greatest degree of fineness, or comminution of particles, *mechanically*, so that the rain, or water applied by hand, may readily change the elements of fertility in the soil from a solid to a fluid, in which state only those elements are available as food for plants of any and every kind. Therefore by reducing the soil very fine, by some mechanical operation, such as plowing its solidity is, in a measure, overcome or destroyed, and the roots of plants find little hindrance in ramifying throughout the entire mass that has been broken up. And if the roots and little spongioles occupy the entire soil, the ten thousand mouths of these roots are ever open to drink in those substances which will promote the growth of the plant. On the contrary, if a large proportion of the soil is in the form of lumps, or is turned over in furrow slices of an unbroken mass, the soil is not in the best, or even in *good* condition, to promote the growth of these plants that occupy it.

321. Now the idea is, in plowing, to use those plows that will break up the solidity of the soil most thoroughly and effectually. Turning the soil upside down, as if it were a huge slab of earth, does not accomplish the desired purpose, as its solidity is not destroyed, except in a very limited degree. Every observing farmer knows that when calcareous and aluminous soils are not too wet, nor too dry, if they are plowed with a kind of plow that leaves the furrow slice on its edge, the pulverization will be about as thorough and complete as it can be made with a common plow;

chanically—until after it has been dissolved by rain or water and reduced to a liquid. Dry earth or dry manure cannot enter the roots of plants. Roots of grain, grass, and trees feed upon nothing but liquid or fluid. When we apply bonedust to plants, rainwater must first dissolve the little fragments of bone and carry them along, where they will be taken up by the thousand mouths in the little roots of the plants. So with the hard soil and hard lumps of earth; they must be reduced to a fine powder, by some mechanical operation, and then the rain will dissolve the fine particles, thus forming a fluid, which is the food of plants. When the soil is very lumpy the atmosphere has but a small surface, comparatively, to act upon; therefore plants grow slowly where the entire soil is one complete clod or is little else but lumps.

PULVERIZATION OF HEAVY SOILS IMPRACTICABLE IF TOO WET.

328. When there is an excess of water in heavy soils, it is utterly impracticable to reduce them to fine tilth with plows and harrows. They may be rendered somewhat fine by cutting and tearing them to pieces; but they cannot be pulverized any more than one can pulverize a batch of dough. When a heavy soil is filled with water instead of air, the more it is plowed or harrowed the more compact it will be when the surplus water has dried out. Sandy soils may be plowed and harrowed in some instances without injury when they are quite wet; but heavy soils must be sufficiently dry to crumble readily when worked, or it will be impossible to reduce them to that degree of fineness which is essential for the roots of plants to spread through them. If a handful of heavy soil, in which there is not an excess of water, be worked with the hands, it will crumble; but when so wet that it will knead like dough, the more it is worked the harder it will be when it comes to dry, and the less suitable its condition to promote the growth of plants. When a heavy soil, just dry enough to crumble well, is plowed with narrow furrow slices or spaded finely, it will be about one-fourth deeper than it was before it was plowed. On the contrary, if plowed when so

wet as to knead and not crumble, it will settle down at once to the same bulk or depth that it had before it was worked.

329. The first thing to be done then toward a thorough pulverization of heavy soils is to drain them. The next is to plow in autumn and apply barn-yard manure; then, in order to increase the quantity of vegetable mould, and keep them light and friable, to raise crops of red clover or Indian corn, to be plowed under when green.

THE PHILOSOPHY OF DEEP PLOWING.

330. The editor of the *Agricultural Review* writes under this caption: "There was a time when the cultivated soil was merely scraped, when the ponderous plow drawn by four horses laid bare the earth but a few inches below the surface. But the memory of the 'oldest inhabitant' hardly goes back to that easy going time, and now manufacturers successively out-do each other in the production of implements by which the soil is thoroughly and deeply pulverized. That deep plowing is beneficial to the soil is admitted by every intelligent farmer; but the particular soil most benefitted by it, and the proper time for the performance of the operation, are subjects on which a variety of opinion prevails. Stiff clay soils are the most benefitted by deep plowing, and the results are still more satisfactory when the subsoil is of the same nature as the supersoil. If the farmer cannot extend the superficial area of his farm, he can, at least, add the cubical contents of its productive portion. By thoroughly breaking up the subsoil, it is exposed to the action of the air; the mineral food of the plants becomes liberated from its latent state and made available, and the sourness, which is a frequent property of the subsoils, disappears. In the working of stiff soils, the labor expended in pulverizing will be highly productive; but care should be taken that the quantity of subsoil brought to the surface is not greater than a winter's frost is sufficient thoroughly to disintegrate. If the land has been recently drained, and the underlying soil exhibits a bluish tint, not more than one and a half inches should be turned over on the surface soil. If too

large a quantity of the infertile subsoil be brought up, the fertility of the land may be seriously impaired for several years. The remedy in this case is the repeated and careful tillage of the surface soil, and the abundant application of manure. If, however, the subsoil be merely broken up by the subsoil plow or spade, and not brought in quantity to the surface, the pulverization may be advantageously made to extend to a much greater depth, and small portions may from time to time be brought to the surface *in the course of tillage. Deep cultivation is inapplicable in the* case of sandy soils, except when they rest upon a stiff subsoil, which, however, is rarely the case. If there be simply a thin strata of stiff clay beneath the sandy soil, it should not always be broken through, as it may prevent the moisture passing away too rapidly as drainage. When friable soil rests on chalk, gravel or sand, deep plowing should not be performed; neither is the operation desirable, but the reverse is the case on any kind of highly manured land. We have often known the manure to be plowed in so deeply that its decomposition took place only after the lapse of several years. Manure, to be efficient, must be as close to the surface as possible, in order that atmospheric influences may decompose it speedily, and that the nourishment afforded by it may be within easy access of the rootlets of the plants. The proper season for deep plowing is in the autumn, in order that the soil may be exposed to the winter's frosts and rains—those potent agents by which the dormant elements of fertility are set free and made available for the summer's crop."

DEEP *vs.* SHALLOW CULTIVATION.

331. A few years since an eminent farmer penned the following thoughts, with reference to plowing in Europe and America: "I am sorry to be obliged to state, that in my opinion, formed from observation, four inches (solid) is still the *full average depth of the agricultural pie-crust in which plants* are to grow whose roots would, if permitted, descend many feet." We question if the "agricultural pie-crust" of Canada is any deeper on the average, and though it yields a large supply of

food for man and beast, let it not be forgotten that there is something *below* the crust, which is capable of adding immensely to that supply. In point of fact, nearly every farmer in the country has a *second* farm, of the possession of which he lives in total ignorance—a new farm under the old one. Farms not only lie side by side, but in layers, and if the rage for *broad* acres could be displaced for *deep* acres, the amount of soil under cultivation might soon be doubled.

332. The objects of plowing are chiefly these: to pulverize the soil so that the air can get into it, and the roots of plants find their way through it; to mingle the different portions of it as thoroughly as possible; to cover manures; to kill weeds, and to keep the surface open and fresh. By bringing fresh portions of earth to the surface, moisture is attracted from the air, and along with moisture various fertilizing gases are absorbed. By keeping the pores of the land, so to speak, open, this process goes on more thoroughly than it can do if the surface is suffered to grow hard and stiff. Deep plowing extends these benefits to a greater depth. It opens a larger proportion of the soil to the beneficial action of air and moisture, and furnishes a more roomy bed for plant roots, and a more capacious store-house for plant-food. It has, to some extent, the same effect as draining. It carries off more or less of the surface water, warms the soil, and renders it more easy of cultivation. Land thus tilled is not so soon exhausted. The roots of grain, by penetrating farther, take firmer hold, and the stocks are less liable to give way and lodge.

333. It also saves labor. It is less work to raise thirty bushels of wheat from one acre than from two or three, to say nothing of the zest and pleasure connected with getting a large instead of a small yield. Deep culture is especially important in the growth of root crops. Those who have only a four inch "pie-crust" to operate upon, have little idea of the size to which turnips, mangolds, carrots, &c., will attain when they have ample range in a rich soil. Rev. Mr. SMITH, of Lois Weedon, one of the most noted agriculturists of the present day, gets his rows of Swedes to "shake hands" by their leaves at *five feet* intervals.

He plows back all his top-soil, and having thus laid bare the poor subsoil, puts manure into it until topsoil and subsoil are alike rich. Dr. DIXON, of Rivenhall, once pulled up a parsnip with a vertical root thirteen feet six inches long, besides a further piece left by its breaking off. This was in a bank of earth twenty feet deep, that fell over loosely when excavated. The roots of strawberry plants, grape-vines, etc., have been known to descend several feet in search of food and moisture. The exposure of a cold, barren subsoil to the action of the atmosphere without the addition of manure, will, in due time, render it capable of producing a crop. How great, then, must be the advantage of both loosening it up and dressing it liberally with dung.

334. Gardeners understand this. A four-inch "pie-crust" will not raise choice vegetables. Hence the land is trenched to the depth of a couple of feet, or at least double-spaded, and manure worked in at a rate that seems almost wasteful, yet it is the very best economy of land, labor and money. Why should not the farm be as deeply tilled as the garden? The reply probably is, because of the expense. The objection would lie if we were confined to slow hand labor with the spade. But the same result can be attained by the use of team and plow. These are inadmissible to gardens because of the limited space for turning and working, and also because there are trees, plants, walks, etc., that would be injured by this mode of culture. But in the open field, team and plow can get down as deeply as the spade. There are two modes by which greater depth of tillage can be attained. One is by deeper plowing with an ordinary surface plow, and the other by the use of the subsoil plow. The surface plow driven deeper down, throws in the furrow made by the other, and simply tears up and loosens the hard-pan. It stirs and mixes up what is under the pie-crust."

335. The change from shallow to deep plowing must be made gradually when it is accomplished with the common plow, put in more deeply, and manure sufficient to enrich what is thrown up from beneath must be applied. An inch at a time may be taken until by successive deepenings the plow can be driven to

the depth of nine or ten inches. The subsoil plow—an implement almost unknown in this country—will effect gradual deepening of the soil without throwing the broken hard pan to the surface. By loosening the subsoil so that the air can penetrate it, it will soon improve and be assimilated to the topsoil. Stronger implements and heavier teams will be needed for the deeper cultivation we are urging; but the results in heavier crops will soon justify and reward the outlay.

PULVERIZING AGENTS.

336. The plow, the harrow, cultivator, roller, clod crusher, hoes, and all other implements, never impart any fertility to soils, nor take any from them. They are only a *means* for accomplishing an end. Z. A. LELAND writes on this subject: "Much, in farming, depends on pulverization. By pulverization I do not mean stirring with the plow, drag, &c., for that does not reduce the particles of the soil. I know of but two effective agents for that purpose—the frost and fermentation by fresh manures. The frost will reduce the lime and clay gravel, and pulverize the earth. Hard freezing will improve the land, although it may injure the winter crop. Then, by applying fresh or coarse manure, and plowing the same deep under, make the corn-field the compost bed; stir it during the summer on the surface, but by no means mix it up with the manure for the first year. The gas rising will make the land mellow and porous if not pulverized, so that it will remain an absorbing soil for many years, and stand the drought well. I have found the decided effect the eighth year."

337. Whether the growth of vegetation depends more upon absorption or evaporation is not easily answered; yet no doubt a free friendly commerce between the earth and atmosphere is generally useful, although, at certain times, a prohibitory duty by way of mulching may benefit the plants. The practical point we arrive at is, finally, how to render slightly absorbent soil more absorbent. The answer is, 1st, by increasing its own depth and fineness; and 2d, by incorporating with it a highly absorbent material. Tillage answers the first indication. Stirring the soil,

breaking the crust, relieving the compactness into which it naturally passes when left at rest, are obviously indirect means of *feeding the plant.* Green manuring, dressing with swamp muck and composts, which contain much vegetable matter in the state of humus, are the most effectual amendments to the soil, and are applicable to all soils, whatever be their character or situation. By the liberal use of a compost of stable manure with swamp muck, effects have been produced in Connecticut which are almost miraculous. I have seen a field, that originally was part of a plain, covered with a coarse gravelly sand, gray, hot and hungry, in two years converted into a dark, rich, moist soil, on which luxuriant crops stood and matured in seasons so adverse that the adjoining fields were completely dried up.

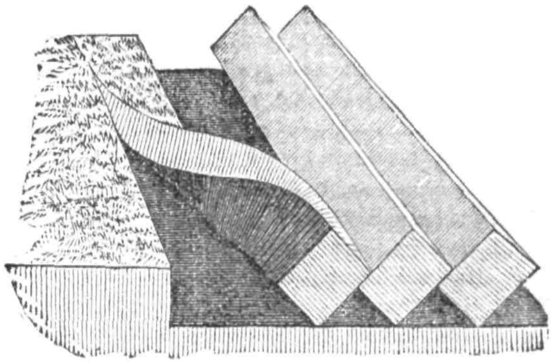
HOW TO DO DIFFERENT KINDS OF PLOWING.

338. A portion of the following paragraphs were penned by the writer for the *American Agriculturist*, and some of the illustrations were prepared by an artist under his supervision, and others were obtained of Ames' Plow Company, Boston, Mass. There are four ways of plowing sod ground in common use, known as "lapped furrow slices, flat furrow slices, trenching, and round furrow slices." The two first are performed with the common plow, while the second may be done with the common or double plow, and the third is accomplished exclusively with the MICHIGAN sod plow, or with one similar to the cylinder plow, an illustration of which is given on a subsequent page.

HOW TO PLOW WITH LAPPFD FURROW SLICES.

339. This operation is illustrated by figure 1, in which the slice is shown as it would appear if the plow were withdrawn from the furrow, slices being about 12 inches wide, 7 deep, and lapping about 3 inches. The illustration shows the third slice in the process of turning. To turn lapped furrow slices, if the team be horses, adjust the traces so that the whiffle-trees will just clear their heels when the team is turning round. Change the land pin, dial clevis, or the index of the hind end of the plow

beam, whichever may be attached, until the plow will run level and true directly after the team. The first furrow will necessarily



LAPPED FURROW SLICES.

be turned flat. In turning the second, drive the team close to the last furrow slice and lean the plow handles to the left until the furrow slice will just lap a little, say not more than an inch on the one turned first. If the double whiffletree or "evener" be more than thirty-two inches from the middle to the point where the single whiffletrees are attached to it, it will be better to shorten it, as it is impossible to make some plows run right by adjusting the clevis, if the double whiffletree is a little too long. When the double whiffletree or ox yoke is too long, and the plow is adjusted to cut a furrow slice eleven or twelve inches wide, it must move more or less sidewise, which makes it hold harder or draw harder.

340. After one round has been plowed, the plow must be adjusted very gradually to cut a little wider or narrower, deeper or more shallow, as may be required to lap the last furrow slice about three inches on the other. The plow should always be held as erect as practicable. If the furrow slice be left standing too much on its lower edge, the plow must be adjusted to run more shallow until it will turn the slice just right, or it must be made

to cut a wider slice and of the same depth, in order to turn well. *The form of the plow will always determine which of these ways* may be adopted. If the mould-board be of such a form as is not calculated for turning deep furrows, the plow must be adjusted to run more shallow, and to cut narrower, until it will turn the slices in the desired position. It is always essential, when plowing sod ground, either with lapped or flat furrow slices, to have the plow cut a certain depth and width in order to turn well, which must be determined by the form of the mould board. The most desirable form of a plow for turning lapped furrow slices is wide at the base, and proportionately narrow at the top of the mould board, with a sharp coulter, a broad and sharp wing on the point, for cutting the furrow slices entirely loose.

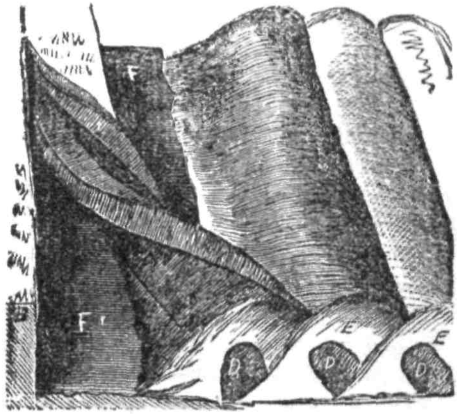
341. F. Holbrook says: "This is a style of plowing much practised in Great Britain, and in some sections of our country where the soil is a stiff clay. As the cut shows, there is a little air space or drain under each furrow slice, and the projecting angles of the surface of the plowed land present the stiff clay soil favorably to the action of the harrow or other surface-working instrument, for the raising of a fine tilth or mellow seed-bed. To execute this mode of plowing in a perfect style, the furrow slices must not be cut more than one-third wider than they are deep, for if they are they will not stand at a steep enough inclination, or rather at an angle of forty-five degrees, which is the best inclination. The usual proportions of furrow slice among finished plowmen are about 6 by 9 and 7 by 10 inches. For a new country, where the land has not yet become cleared of obstructions, nor its surface much smoothed, this is a difficult style of plowing to execute well; and, indeed, it is better adapted to an old than a new country. For plowing more than seven inches deep, the sod and subsoil style of plowing is preferable, even in clay land, being easier of good execution, lighter in draught, and requiring less width of slice than even the lapped style, and therefore making a finer tilth of the clay."

342. I have always found in plowing sod with a common plow and lapped furrow slices that the plowing could be done a

little better to have the wing of the share so narrow that it would not cut off the slice by about two inches. This two inches tends to keep the slice from being crowded so far into the previous furrow that it would not turn well. I find there is not a little difficulty, after all that has been penned, in giving suitable directions for a beginner to enable him to plow well, without several years of practice. It would be less difficult to handle the plow than the pen in this matter. A man needs to practise several years before he can be called a good plowman.

PLOWING WITH A DOUBLE PLOW.

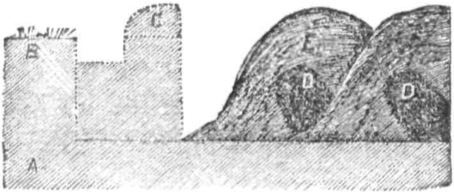
343. Plows with which work resembling the accompanying illustration is done, are familiarly known as Michigan or Double



DOUBLE FURROW SLICES.

Plows. They include all those plows which have a small plow attached to the beam in front of a large one, and are or should be used only in deep soil. The engravings illustrate the working of these plows when cutting a slice about as deep as wide. The little plow or skim, as it is appropriately termed, cuts a slice of turf about half the width of the furrow and turns it over flat laying two grass sides together as in *C*. Then the large plow

attached to the same beam follows, turning this double section of sod nearly in the bottom of the previous furrow, dropping it nearly on the edge, as shown at *D*, and covering it with pulverized soil *E*, several inches deep. When a proportionally wider furrow is plowed, the same effect takes place, but with less regularity. If, however, the slice cut is so narrow that the skim slice is turned off into the furrow *F*, then the sod is buried flat



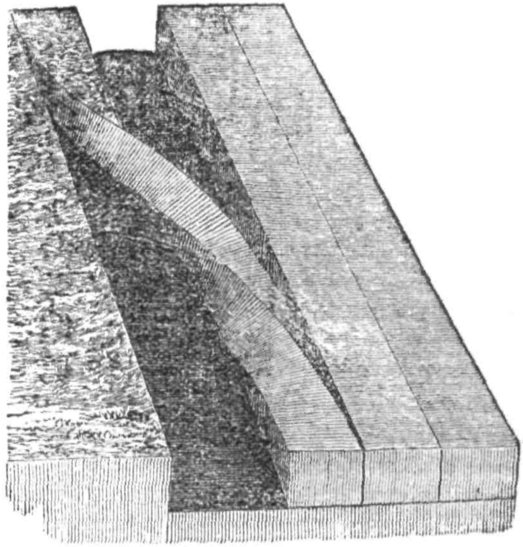
CROSS SECTION OF FURROWS.

in the bottom of the furrow. Thus used, these plows are very useful in a sort of trench-plowing, where it is desirable to bury the top soil, or a dressing of manure, 12 inches or more beneath the surface. The top of the soil may be quite deeply and thoroughly worked without stirring the sods or manure.

HOW TO TURN FLAT FURROW SLICES.

344. The "flat furrow slice" involves a complete inversion of the sod, as shown in the next figure, which is particularly desirable on light loamy soils. For turning flat furrow slices, the plow should be adjusted as for any other plowing, except the coulter should be set so as to cut under a little instead of straight down; and the clevis must be set so that the plow will cut not quite wide enough when the handles are held erect. In plowing, the handles must be inclined more or less to the right. A plow having a narrow base and broad at the top of the mould board is desirable. The width of the furrow slices must be greater in proportion to the depth, especially when turned with certain plows. With some plows it is quite difficult to turn a flat furrow, while with others, either flat or lapped slices may be turned as described.

When a plow runs seven or eight inches deep in order to turn the slices flat, it must cut from fourteen to sixteen inches wide.



FLAT FURROW SLICES.

A skillful plowman will soon learn how to adjust to turn a flat slice. But where it is desirable to plow much land with flat furrow slices, a plow should be obtained that is better adapted to turning flat than lapped furrows.

345. F. HOLBROOK writes on the subject of turning flat furrow slices: "For the breaking up of bushy, rooty, or uneven pastures, or any other grass land, when there are too many obstructions, or the surface is too rough, or the sod is too stiff and rooty with wild or swamp grasses for the safe and effective use of the double plow, the single or flat-furrowed greensward plowing is the better style. The accompanying cut shows at a glance the proper flexure and movement of the greensward flat-furrow slice. For perfect plowing, with the lightest practicable

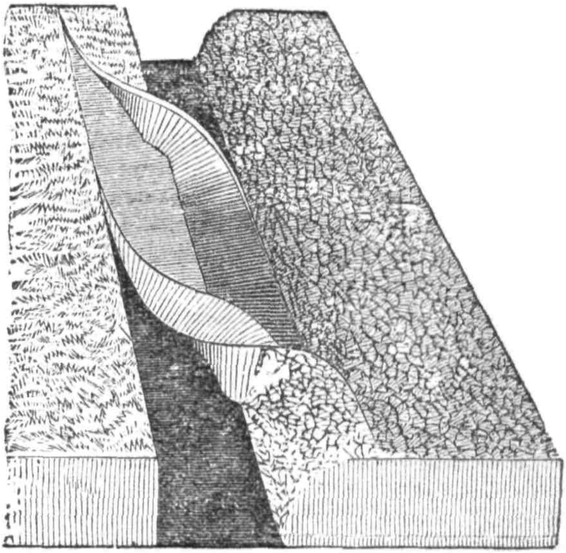
draft upon the team, the furrow slice should have an exact mathematical curvature and equality of twist throughout its entire passage over—as is represented in the cut. It should be the effort and pride of the plowman to be able to adjust his line of draft, or his hitch to the plow, so as to have it meet the peculiarities of the movement of the team—no two teams hardly ever drawing a plow exactly alike—so that his plow will readily take the precise right depth and width of the furrow, and hold easily in it, and so that he can perfectly and instantly control or vary the bias of the plow, to meet the peculiar lay of the land anywhere, and bring the furrow slice over handsomely into its place, and preserve the perfection of his furrows. These little tricks and arts of the true plowman's trade should be learned by every one who pretends to hold a break-up plow; and surely no good farmer can consider them beneath his attainment. For your rough or unsubdued sod land, you will do well to plow the flat sod furrow, using a plow of sufficient strength and capacity for a team of four horses or oxen, when required, and carrying a depth of furrow 8 to 10 inches in good style.

TRENCH PLOWING.

346. Trench plowing is frequently spoken of as subsoiling, and *vice versa*. But trench plowing is not subsoiling; neither is subsoiling trench plowing. Many farmers, when they have plowed deep, turning up a few inches of the subsoil, have supposed they were subsoiling. The accompanying illustration will furnish a very correct idea of trench plowing. A thin sod is removed by a skim plow forward of the main plow on the same beam, and laid up side down in the bottom of the furrow; while the soil ten or more inches below the surface is turned up to the light of the sun and the influence of the atmosphere. (See Subsoiling Defined, paragraph 394.)

347. *Moore's Rural New Yorker* says, on this subject: "Experienced farmers often assert that they have tried subsoiling land, and instead of good effects following, the result seemed to indicate an injury. Not long since a farmer was detailing his

experience, and asserted his disbelief in the good effects of subsoil plowing in very emphatic terms. He had tried it, and his crop



TRENCH PLOWING.

had failed the season following every experiment. He was astonished when we told him we did not believe he had ever used a subsoil plow in his life; he was slightly indignant. Did we believe he would lie about it? No, but he evidently did not know the difference between subsoil and trench plowing. We explained to him the difference, and he seemed satisfied that he knew much less about subsoil plowing than he thought he did.

348 This subject has been frequently brought to our notice; and, recently, we have had repeated inquiries as to the relative benefits of trench and subsoil plowing. We propose to indicate some of the advantages to be derived from each, and compare their effect upon soils and crops respectively.

349. *Trench plowing* is deep plowing, and turning the subsoil

on the surface. It matters little what the character of the soil may be, (excepting light sandy soils, always,) trench plowing ought always to be done in the fall—especially if the stratum of soil is to be turned to the surface that has never been disturbed before. *For one of the great benefits derived from trench plowing is that resulting from the exposure of new soil to the influences of frost, light and heat, thus preparing it for the work of germination and production.* It is more rarely the case that trench plowing in the spring results in an immediate increase of the crop. It is only on old and worn and very light soils that *good effects follow spring trenching—we mean immediate effects.* Where trench plowing is practised in the spring, the farmer should by no means be too ambitious to plow deep. If he has been plowing four, six or eight inches, he should by no means spasmodically double the depth because he has a new notion and a new plow. The depth should be gradually increased, if the subsoil is to be turned to the surface. Two inches deeper each year is enough, and sometimes more than enough with the trench plow in spring. Then the soil thus thrown to the surface should be thoroughly *incorporated or mixed* with the soil that has been exposed previous years. Trench plowing is beneficial to light soils underlaid with clay —to soils containing a large proportion of *humus*—to old worn soils that have been plowed, cropped and manured for a series of years. But trench plowing should be done, on stiff soils especially, in the fall; on light sandy soils it is better done in the spring."

BENEFITS OF TRENCH PLOWING.

350. The necessity of trench plowing has been frequently adverted to, for the purpose of bringing the phosphates to the surface. In loosening the soil, the minerals settle down on the hard-pan, and their beneficial effects are lost. By trench plowing, they are again brought to the surface, and rendered available for plants.

351. Another benefit of trenching is, that it brings the protoxide of iron, which is poisonous to plants, to the surface, and exposes it to the action of the oxygen in the atmosphere, by

which it becomes oxygenated, or peroxide of iron, and is beneficial. Earths only become fertile after having become oxygenated or oxydized by exposure to the atmosphere for a considerable length of time.

352. Trenching, then, though ultimately beneficial in creating a greater depth of arable soil, at first lessens the fertility of the ground in spite of manures. It must be exposed to the action of the atmosphere for a while before its beneficial effects are seen. It is only after the subsoil stratum, and the minerals in it are charged with oxygen from the atmosphere, that its beneficial effects are realized. In deciding as to the propriety of subsoiling, the nature of the ground must be taken into consideration. Unless the subsoil is loose and porous, so that the water can easily pass off, or the land is previously well drained, subsoiling is not to be recommended. But loosening a part of the subsoil, while the underlayer is a stiff, adhesive clay, is injurious rather than beneficial. Until there is some way for the escape of the water, the larger the amount of surface loosened the greater the space for holding water.

353. If ground is properly drained, or the subsoil is sufficiently loose to allow the water to percolate down through it, the effect of subsoiling is remarkable. An English agriculturist says that a crop, after draining and subsoiling, "was four times the quantity in weight ever produced in the same field at any previous time." Another English farmer says: "When land has been thoroughly drained, deeply wrought, and well manured, the most promising sterile soil becomes a deep, rich loam, rivaling in fertility the best natural land in the country; and from being fitted for raising only scanty crops of common oats, will bear good crops of from 32 to 48 bushels of wheat per statute acre." The same farmer says when he commenced operations on his farm, he "had not more than from four to four and a half inches of surface soil; but having applied the system of thorough draining to it, and used the subsoil plow, he can now turn up more than sixteen inches of good soil."

354. But, as before remarked, these effects are not to be

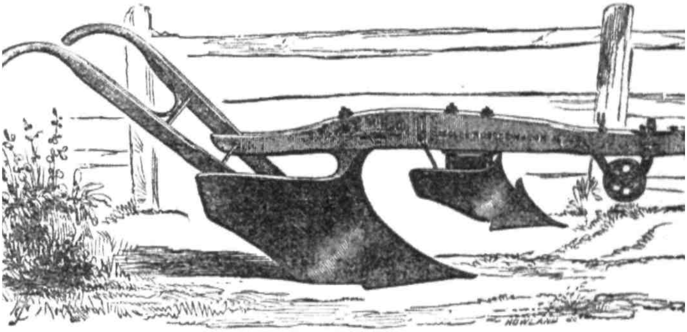
expected from a strong, adhesive clay soil; this cannot be permanently improved by subsoiling. The first operation on such land should be thorough draining, and then pulverizing by plowing in unrotted manure, clover, or buckwheat when in bloom. Such soils may be thus prepared for subsoiling.

SOD AND SUBSOIL PLOWING.

355. The preceding illustration represents the manner of turning the sod and furrow slices when a very narrow slice is cut with a Michigan Sod Plow. F. Holbrook and some other writers denominate it sod and subsoil plowing. He says: "This kind of plowing requires two plows upon one beam. The forward or skim plow should take a depth of not more than two or three inches, dropping the sod accurately into the channel, grass side down; and the rear plow should lift the remaining depth or under soil, raising it high, and laying it handsomely over the sod or skim furrow slice, and well matched up to the previous furrow, breaking the soil well in the act, and leaving a clean channel behind for the reception of the next furrow slices. When a well-constructed plow for this kind of work is accurately adjusted as to the line of draught, and held so as to cut a uniform width and depth, and turn up the rear furrow slice to meet fully the preceding one, as represented in the cut, the upturned soil is laid over in a remarkably light pulverized condition, making a very level and finely cracked and open seed-bed or tilth, superior to what can be done with any other implement yet introduced, and indeed superior to what the most accomplished spadesman could do in grass land by hand labor. For the deep breaking up of sod land I would recommend the sod and subsoil style of plowing, on all such as are free enough of obstructions, and have sufficient regularity of surface to admit of the use of a double plow. Deep plowing is done with lighter draft to the team by this mode than by any other, because you can plow quite a narrow furrow in proportion to depth—say ten inches deep, by eleven or twelve inches wide—while by other modes you would be obliged to carry at least from a third to a half more width than depth to turn the furrow surely.

MICHIGAN SOD AND SUBSOIL PLOW.

The cut of the double plow accompanying this paragraph is manufactured by the Ames' Plow Company, Boston, Mass. It



MICHIGAN SOD AND SUBSOIL PLOW.

is used for the most part in fall plowing, as represented by illustrations, (Paragraph 343.) The most important suggestions in using this plow is to set the small one about one fourth of an inch more to land than the large plow cuts; and run the small one not less than two inches deep. When it cuts a very thin slice, it increases the draught very much; because it runs directly among the roots of grass. When the point runs below them, the draught is lighter. The forward mould-board is connected with the beam, and its depth of furrow is adjusted as follows: *A substantial iron flange is fastened to the under side of the* plow-beam by two bolts passing up through the flange and the beam, and made tight on top by nuts and screws; the flange has two rows of slots in it to receive the bolts from the land-side of the forward plow, and the plow is made fast to the flange by bolts and nuts. By means of the slots in the flange, the forward plow may be raised or lowered, according to the depth of plowing desired, and made fast at the requisite point to give the depth desired. The forward mould-board turns the sod-furrow as wide as the working of the whole plow, and the earth on top assum-

sixteen inches deep—for the purpose of forming a deep soil for a pear orchard. See best works on fruit culture for best modes of preparing soil for fruit trees. Here the subsoil was of a very different character from that alluded to in the foregoing *paragraphs*. There was very little mould among the soil. And the result was, that crops were a long time in getting started after it was plowed deep, because the surface would be so very hard. Crops would grow very slowly, and the yield would be small for several successive seasons.

361. It was thoroughly underdrained with tile and stone, about two rods apart, with drains from thirty to forty-five inches deep; was manured abundantly every two or three years; was plowed in autumn, for the purpose of securing more complete pulverization; and a large and heavy crop of Indian corn sowed broad cast was plowed under, all of which combined rendered it a very productive soil for cereal grain and grass. But it was too compact and heavy for raising roots, carrots, turnips, parsnips or potatoes.

362. Besides my own experience on this subject, I met with similar instances all over the country, where farmers had turned what little mould there was on the surface some eight or ten inches below it; and had brought up a new stratum of cold, heavy and unfriable earth, which was not fertile enough to be called soil, and which would require many years of judicious management to render it a good fertile soil.

363. On many of the slopes of our lakes, where the soil was thin and resting on a compact calcareous gravelly clay, many farmers, after seeing the excellent effects of plowing deep on the uplands, where the soil was a deep, black mould, resting immediately on a fertile subsoil of gravelly or clayey loam, instead of loosening up this hard substratum with the subsoil plow, have put a double team to one plow, and rolled up huge furrow slices of barren earth, and for a number of years have rendered their good soils about worthless. The ill effects of such deep plowing were discovered immediately. But the next generation of farmers will find that their predecessors committed one error in plowing such soils that will result in much profit to them.

PRACTICAL EFFECTS OF DEEP PLOWING.

364. The prevailing practice among the majority of farmers all through Central New York used to be, to plow shallow, and not to turn up any of the yellow dirt. Consequently, as they did not pay much attention to keeping up the fertility of their virgin soils, they soon became so much impoverished that their crops would hardly pay the expense of cultivation. I remember well a certain large farm that was managed on the "skinning" and "skimming" system—plowing shallow and carrying everything off the soil, and returning nothing to it—which came into the possession of a man who hitched two teams to one plow; and turned up several inches in depth of the fertile subsoil; and drained the wet portions of it; and plowed under some clover, and all the coarse strawy manure that he could collect; and by this means he raised large crops of winter wheat, when his neighbors could not raise half of a crop; and his crops were quite as heavy as the soil ever produced when the land was first cultivated. It was a common remark among his neighbors, that he had turned up a new soil. Every one who observed the effect attributed his large crops to the deep plowing. And this was correct, because for more than thirty years only a thin stratum of soil had been cultivated. And as the subsoil, for the most part, was well filled with available nourishment for promoting the growth of the wheat plant, it was almost like a new soil, because it had never been cropped.

365. On many of our river bottom lands, where the soil had been plowed shallow for many years, deep plowing has often increased the quantity of the crop from one-third to one-half the usual quantity. But the intelligent farmer will perceive that soils should never be plowed deep with a common plow, where there is but a thin stratum of mould resting on a compact, cold, and barren subsoil. Many good farmers all over the country have related their experience in deep plowing, and it has been condemned about as often as it has been recommended But by inquiry it will always be found *that the kind of*

subsoil would always determine the success or the failure of the experiment. And the quality of the subsoil— or the quality of the lower part of the soil—will always afford proper instruction when to plow deep with a common plow, as well as when to deepen the soil with a subsoil plow, thus keeping the best soil on the surface of the ground.

EXPERIMENTS IN DEEP PLOWING.

366. WM. D. SHELDON, of Wayne Co., gives in the *Rural New Yorker* the result of two experiments in turning up the subsoil, which may prove instructive to our readers. He says: "I purchased a farm a few years ago that had been worn out by constant shallow plowing. The first year I sowed five acres to oats, upon a ridge which had a gravelly hard-pan some six inches below the surface, and the crop was hardly worth cutting. Plowed it shallow. The next year I used the Michigan Double Plow, running it ten inches deep, which brought up some four inches hard-pan. The oats on the average were four and a half feet high—the largest growth I ever saw. The five acres filled a 30 by 40 barn from bottom to top, and a part of the barn floor. There was not enough lodged on the whole field to make one bundle—the straw was strong, and so harsh that the stock had no inclination to eat it. Another lot on the same farm, on a flat, I plowed about one foot deep. The soil was a black sand; the result was the reverse of the above—it nearly spoiled the land."

367. HIRAM WALKER, Mexico, Oswego Co., N. Y., wrote the following letter to the *Country Gentleman:* "The land on which I have tried deep subsoil plowing is a clayey loam, with a very retentive subsoil. I began five years ago by following the large Peekskill Plow with Starbuck's subsoil plow in the same furrow. The subsoil plow does not cut more than two-thirds as wide as other plows, and merely raises the earth some four inches, and falls back in its original bed, leaving a strip of earth between the furrows undisturbed.

368. After going over ten acres in this way, I thought I

might more effectually stir the whole subsoil strata by cutting both furrows with the same plow. I then ganged my sod plow to cut six inches deep. By having the draft raised, and throwing the roller into the furrow, I could easily cut the second furrow in the bottom of the first without any alteration of the draft or the roller. This was much more convenient than to change plows every round, as I did when using two plows, as I performed the work with a single team. In performing the work with a single plow, I stirred the whole earth the depth I plowed, raising part of the subsoil furrow to the surface, so that at the next plowing the sod and subsoil furrows will be well mixed together.

369. "I have cultivated fifty acres in this way during the last five years. Most of this plowing has been done with Remington's large size steel plow, made at Ilion, N. Y. The land I have cultivated, as above stated, is nearly free from stone, and much of it so adhesive a nature that an iron plow, however bright, would load up the mould-board, while the steel plow would always keep clean and save 25 per cent. in the draft. Any plow will clean itself in loose gravelly soils. I do not think it necessary to subsoil loose, porous soils whose tendency is to leach, as they are loose enough without.

370. I prefer to subsoil in the fall—first, because there is more time for this extra work, and teams are strong; and secondly, because clayey grounds may be quite moist and pasty, and any lumps of clay thrown up will be slaked and left light by the frost of winter and April winds. Land thus fall plowed is left loose, and the air penetrates it till it is worked in the spring, thereby improving the subsoil for vegetation.

371. I have had better crops on land worked as above than before, as it lets the air mingle with the soil at a greater depth; water recedes from the surface quicker, and I can run my plow to a depth with ease that could not be done before."

372. The Editor of the *Agricultural Gazette* says: "Light land, whether sandy or gravelly, cannot have its naturally uncertain productive capacities fully developed without deep cultivation. If a hole be dug in search of gravel or sand, and the

soil be simply put back again, that place will retain its luxuriance of growth much longer than the soil adjoining, where the field has merely been subjected to ordinary shallow plowing.

373. To create two feet of well-filled soil, instead of nine inches of it, is to give the soil a greatly increased power of retaining moisture. A piece of pumice stone will occupy far less space when smashed to powder. Its capacity to resist the escape of moisture will be proportionately increased. Light soil is of a somewhat corresponding structure; and by first stirring it as deep as possible, and then compressing it into a compact, united mass of stone, not only are fresh substances made available for roots to feed on, but its natural moisture is retained for use by the growing plant.

374. Heavy or clay land, even if underdrained, would be greatly benefitted by deep autumn cultivation, if well furrowed out subsequently. Drainage, in any case a fertilizer, is, in such a case, the first necessity, and deep cultivation is the second requisite, if profitable crops be the object. If soil be deepened and pulverized, and just enough ammoniacal or other stimulating manure be applied to cause the first development of green crop, enable it to feed freely on the air, and if this crop be turned in to decompose, an addition of every element of food for plants will be made to the soil. All that need be guarded against in practising deep cultivation, is bringing up merely mineral earth from below more rapidly than it can be easily converted into soil by tillage and exposure."

375. A practical farmer writes to the *Rural New Yorker:* "We have abundant evidence, from various sources, of the superior benefits obtained from plowing eight or ten inches deep, instead of five or six, as was once the almost universal custom. Yet many still continue the old practice, asserting that they have tried the other and found it injurious, the crops invariably depreciating on lands thus treated. Now, what is the cause of this discrepancy in results? We assert that in every case where the subsoil is of equal or superior fertility to the surface, and has been subjected to the ameliorating influence of the atmosphere

for a short time, that deep plowing increases the crop. But, unfortunately, many of our soils a few inches below the surface are nearly barren; and to throw up, say four inches, of this barren soil to the surface, and without cross-plowing or mixing it with the mould, sow the grain on it and drag it in, no wonder that the young plants, in their vain struggle to find nourishment, should dwindle and die. But it is believed that such, or in fact any soil, can ultimately be benefitted by deep plowing, if judiciously performed. We would, in the above case, deepen but one inch the first year, and mix well together, manuring, if necessary, and then in one, two or three years, according to circumstances, deepen another inch, and so continue until you have a soil as deep as one pair of oxen or horses will ordinarily plow with a *good* plow, which is about ten inches."

DEEP PLOWING IN NEW ENGLAND.

376. Although the plowing in the New England States is done with a single team, for the most part, and only four, five and six inches deep at that, yet, in many instances, a double, *triple* and *even a quadruple team is used to draw a single* plow. Many of the fertile intervale soils bordering on the rivers have a very deep as well as fertile soil; and the deeper they are plowed the more productive they are. I have my mind on fertile river bottom lands on the Merrimac River, that are always plowed as deep as four good horses are able to draw a plow. And there is no danger of ever injuring such soils by deep plowing. Levi Bartlett, an excellent correspondent of the *Country Gentleman*, when alluding to the amount of team employed to plow the soil on the Webster farm, in N. H., says: "The present owner was plowing an eight-acre field of sward land. This was in the month of September. The team consisted of three large yokes of oxen and a heavy pair of horses. The soil was alluvial, as free from stones, stumps, &c., as the prairies of the West; furrows 12 inches deep, by 18 in width. A less team could have done the work; but as the owner of the farm had that amount of team, he put it into the field. I have seen

good plowing done here by a pair of horses or a pair of oxen. Some of our land is as light and easy to plow as the limestone soils of Western Virginia. In Concord there are men that plow these intervales at six dollars per acre, with four good horses. The crop of corn grown, with good culture and manure, averages sixty bushels per acre. A crop of corn of sixty bushels per acre, in many sections out West, will sell for only six dollars—just what it costs to plow an acre of land in the Granite State."

377. *In many other places in the "Old Granite State,"* after the rocks and small stones have been removed, the soil is deeper than most farmers ever desire to plow. But the intelligent reader must heed the warning given in preceding paragraphs, not to turn up a stratum of barren subsoil, and spoil his land, because somebody else has found very deep plowing to be productive of an increase of crops

RESULT OF DEEP PLOWING IN PENNSYLVANIA.

378. A practical farmer writes thus to the *Germantown Telegraph:* "There is no subject in agriculture more worthy of consideration than that of plowing deep in the fall, under certain circumstances. My experience on this subject has shown me, that clayey and slate soils may be greatly benefitted by plowing deep in the fall, exposing the soil to the action of the air and frost during the winter. Experience has also taught me, that plowing clayey soils deep in the spring, so as to turn up two or three inches of soil never before exposed to air, is sure to be a failure in the first crop. After being thus exposed for one year to the atmosphere, and plowed the following spring, the increase in the next crop will be plainly seen, proving the advantage of plowing such lands deep in the fall. *On slaty soils I have seen far greater results from this method.*

379. A portion of my farm is slate. I was told by one of my neighbors that a part of this slate had been under the plow for over twenty years. The owner tried a number of times to seed it, but without success. I commenced plowing this piece of land with the intention of restoring it to fertility. I plowed it beam

deep, and sowed oats in the spring, and seeded to June clover. The result was more than I expected. A uniform growth of oats, three feet high, was the result. The next June I mowed one and a half tons per acre of good clover hay upon said land. I commenced plowing in the clover on the 15th of September, and sowed to winter wheat. The July following I harvested a fair crop of wheat, considering the amount of insects which worked upon it. I plowed again in the fall, and sowed oats in the spring, expecting that there would be clover seed enough left to seed it; but in this I was disappointed; the result was a fair crop of oats for this year; I have plowed again this fall with the intention of seeding next spring.

380. Another piece adjoining I plowed in the fall, and sowed with oats in the spring. I harvested what the insects left after doing their work, which was 45 bushels per acre. Said piece of land did not produce more than 40 bushels of ears of corn per acre the year before. I have satisfied myself that there must be some power in slate stone for the growth of vegetation, when brought into a state to be acted upon by the roots of plants, which is done by the action of heat and cold, in pulverizing the slate.

381. Geology and experience have taught us that no soil, unless exposed to the atmosphere, will vegetate the least plant. We may take swamp muck, as an example, which experience teaches will be of no use until brought to the air, and changed by a chemical process in uniting with some other substance, or the action of the atmosphere upon it, thus changing it into a valuable manure. In the other case, the soil is not so much saturated with water, as in the former, and nature is, in this case, her own remedy, when the soil is exposed to the atmosphere. The distance to which air penetrates clayey soils cannot be more than two or three inches when plowed shallow. While with deep plowing it may penetrate to three times that depth.

FALL AND WINTER PLOWING.

382. It seems not a little surprising that there should be so

many farmers, in this age of intelligence, who will so strenuously insist upon the inexpediency of fall or winter plowing. It would seem that after a few successful experiments in fall plowing every farmer would be not only ready, but *in haste*, to avail himself of the great benefits of plowing deep in the fall. But we find a great number who have come deliberately to the conclusion, that they do not get as good crops from these fields which were plowed in the fall as from those which are plowed only in the spring. Many contend that when land is plowed in the fall, (especially sward land), the crop, especially if it be corn, will be very much injured the ensuing year by the worms. Others say that they have experimented in fall plowing, and have become satisfied that they do not get as good crops as from spring plowing only.

383. We grant, in a measure, the truthfulness of both these objections; but, at the same time, we would advocate late fall plowing, except when the soil is very sandy, or a sandy loam. It is true that there are soils which it would not be well to plow in the fall, on account of their disposition to leach. After a farmer finds, by a few fair experiments on such soils, that he obtains greater crops from spring plowing *only*, than from fall or winter plowing, the practice should be abandoned at once. On very porous, light sandy soils, on gravelly loams, and all other kinds of soil which are not accustomed to bake and to become lumpy, the rains and snow and frosts of winter have no ameliorating effect, because if we increase their porosity and friability it is done at the hazard of their fertility

THE OBJECT OF FALL PLOWING.

384. The grand object to be attained in fall or winter plowing is to increase the friability and porosity of soils, and to destroy the worms. If the soil is already very porous and friable, there is too much reason for apprehending that much of the elements of fertility will be washed out by drenching rains, and thus the soil would be impoverished rather than made more fertile. But, generally speaking, all soils that are apt to be lumpy

when they are plowed where there is not an excess of moisture, and inclined to bake in spring and summer, clayey loams, calcareous soils, and thin soils of muck lying on a subsoil of clayey loam and gravelly clay, will be greatly benefitted by being turned up to the influence of the rains and frosts of winter. If a soil has been thoroughly drained, but is very wet from heavy rains, we need entertain no fears that fall plowing will injure it; because, should it be so wet as to run together like mortar, the rains and frosts will destroy this cohesion. But if a soil is not thoroughly drained, we need expect no benefit to result from plowing such soils in the fall or winter. I will tell why. A soil that is thoroughly saturated with water will expand but little, if any more, than the same bulk of water when it congeals; and when it thaws, much of the finer particles run together like lime, sand, and loam, when they are made into mortar, holding in this mass the elements of fertility so firmly, that as food for plants they are in an unavailable state. But when soil that is only moistened freezes, its bulk is greatly increased, and the cohesion of every part is affected; and when it thaws, there being not water enough to allow the different particles to run or settle together, it remains light and friable like honey-comb; and each successive freezing increases its porosity and breaks up this coarseness of particles.

385. Another object in plowing late in autumn is, the destruction of numerous insects that are injurious to vegetation. When insects are turned up from their winter quarters in cold weather, they are not lively enough to descend again into the soil. Therefore many of them perish.

386. When a soil is plowed early in autumn, if there are many worms in it, there is danger that they will seriously injure the crop the following season. But if the plowing is deferred until late in the autumn, or even until winter, a great majority of them will perish after being routed from their winter quarters. And, furthermore, when sward land is plowed early in autumn, the grass roots on which the worms would have fed while the crop is growing, will have decayed long before the crop in the following

season is out of danger from the worms. But if land be plowed late in autumn, or winter, the grass roots undergo but little change, and will furnish food for worms, as well as if the soil had been plowed in the spring. I have known many crops materially injured by the worms in consequence of plowing too early in autumn. A few years since a neighbor cut a ditch through one of his pastures, in the month of September, and on the following season plowed in the spring, and planted with corn. Along this ditch, a strip, about six or eight feet wide, was almost entirely destroyed by worms, while the rest of the field yielded a bountiful crop.

THE EFFECT OF FALL PLOWING WET GROUND ILLUSTRATED.

387. In order to illustrate this subject, let any one take some unslacked lime and wet it just enough to make it slack well, and it will afford a beautiful example of the effect of rain and frost on a dry soil that has been plowed in the winter. Now, take another quantity of lime and continue to pour on water, more than is necessary to slack it; and after it is slacked, stir it with a stick and let it settle. Now let the water evaporate, and let the lime freeze and thaw, and we are furnished with a very correct idea of the effect which fall or winter plowing has on a soil that has an excess of moisture in it. In many parts of the country a thin soil rests on a heavy, compact substratum, sometimes called "hard-pan," which is often said to reach as far as the second rail of the fence; and it is often plowed when water will stand in the furrows. But labor expended in plowing such soils when so wet is of very little benefit to them. So long as the interstices of the soil are filled with water the soil is dead. It cannot be pulverized, and plants cannot grow. It must be drained. It is the height of folly to attempt to grow any kind of crops on such a soil without first removing the surplus water. I shall reiterate this thought from the beginning to the end of this book—*drain all heavy soils when there is any superfluous moisture.*

THE EXPERIENCE OF OTHERS IN FALL PLOWING.

388. We have made extensive observations on this subject, in reading agricultural papers for more than twenty years past; and the testimony from farmers all over the country is universally in favor of the practice. A correspondent of the *Rural New Yorker* writes: "Fall plowing I think an important item in farm operations, for past experience has taught me that better crops of barley and oats may be secured, *on any of our lands*, by plowing in the fall; and we can invariably get them in, in better condition. I consider it indispensable, however, that no surface water be allowed to remain long; and neglect in this respect I believe to be the cause of so many failures in the experiment. Some say, 'plow dry land, but you must not plow those which are wet;' but, with all deference to the opinions of such, I, from past experience, advise to the contrary. If I have a rather wet clayey lot which is intended for spring crops, I plow in the fall; not, however, in an indifferent manner, as is the practice of some, but with great care, putting it in narrow beds, and cutting cross furrows or ditches, in order that all the surface water may quickly run off and not lay upon the land to harden it. In this condition the legitimate effect of the frost is to pulverize the soil; and, when spring comes, once harrowing, and then going over it with the wheel cultivator, will put it in as good condition for sowing as it possibly can be."

389. A correspondent of the *Cultivator* writes: "I noticed an article on fall and winter plowing, in which it was highly recommended to plow in the fall, except on sandy or sandy loam soils —the writer taking the ground that such soils will leach if plowed in the fall. I do not know but it is so; but I have yet to learn that if you plow such a soil in the fall it is at the hazard of its fertility—especially if it is sward land, and the first crop is intended to be corn. Instead of the action of the frost and snow of winter increasing the porosity and friability of such a soil, it tends to settle it down together, and renders it less liable to be affected by the drouth, which is something to be thought of

when we have such dry seasons as we have had for two years past; and then the sod rots earlier than it would if it were plowed in the spring, and gives its fertilizing qualities as a manure to the young corn as it just commences to grow—a time when it is needed, if ever, to push it forward, so that the hoe can be used to keep the weeds in subjection. Last year I had a field of corn of some eight acres; a little more than half was plowed in the fall, and the rest in spring. When I came to harvest it, that plowed in the fall was nearly if not quite one-third the best; a great deal heavier growth of stalks and longer ears; and it stood the drouth better by half. Where it was plowed in the spring, the corn leaves began to roll a week or ten days before they did where it was plowed in the fall; and when there came any rain, it seemed to leach through and leave the ground as dry as ever. I am in favor of fall plowing for any crop. It is equally as good for other crops as for corn, as far as my experience goes."

SUGGESTIONS AGAINST FALL PLOWING.

390. O. C. GIBBS, M. D., Ohio, writes to the *Country Gentleman:* "We seldom look into an agricultural paper, in the later months of autumn, without seeing fall plowing recommended for spring crops. Believing this advice to be, in most cases, injudicious, and founded upon erroneous principles of agriculture, I shall offer a few suggestions in support of this opinion.

391. The great stimulus to every form of cultivation, so far as the soil is concerned, is admitted by all to be the quantity of organized matter in the soil, in a state of disorganization or decomposition. Now, irrigation and pulverization of the soil promote the disorganization of those organic elements, and render them active for the development and support of vegetation; and if there be no crop upon the land to receive that stimulus, or if the surface of the land be not in some way protected, so as to prevent the escape of those fertilizing elements, rendered gaseous by the process of decomposition, they are, in a great measure, evaporated and utterly lost to the soil. Hence, land is im-

poverished nearly, if not quite as much, by fall plowing, preparatory to spring crop, as though a crop had actually been taken from it without any return. Land may, perhaps, be tilled a little earlier in the spring for the fall plowing; but in Ohio, at least, it can be tilled early enough for corn, spring wheat, oats, &c., without this impoverishing preparative. At any rate, where autumn plowing facilitates early culture, under-draining would be far more beneficial, and not open to the serious objection which we urge against the measure under discussion. It is thought by most of the advocates of fall plowing that it destroys the cut-worm, so injurious, sometimes, to the corn crop. But this, I think, is questionable. Though the worms be exposed to the action of the elements, yet I submit the inquiry, how long would it take them to penetrate again beyond the reach of frosts? And would not their unerring instinct prompt them to avail themselves of this sure protection? Be this as it may, in reference to the cut-worm one thing is certain, and many farmers have experimentally learned the fact, that fall plowing injures the soil as effectually as it does the worms. It is said that fall plowing renders the land much easier tilled the coming spring; this, in reference to some soils, is doubtless true, and is the only real advantage the system possesses; and this certainly ought not to weigh against attending evils."

392. We have quoted the foregoing letter simply to show what could be said against fall plowing. But it may be seen that the tenor of the writer's arguments appear very like the defense of a man who knows and feels that all the facts in the case and all the knock-down arguments are on the side of his antagonist; and himself would like a good opportunity to skedaddle with his tail of—feathers drooping. That land "is impoverished by fall plowing" there is no evidence at all. Fall plowing will, doubtless, destroy many worms if it be done in late autumn; because, if their winter quarters be disturbed, they will not possess vitality enough to descend again beneath the surface, unless the weather were unusually warm. The very best argument against the theory advanced that fall plowing impoverishes the soil is,

that much better crops are always attained on heavy soil by fall plowing where there is not an excess of water in it.

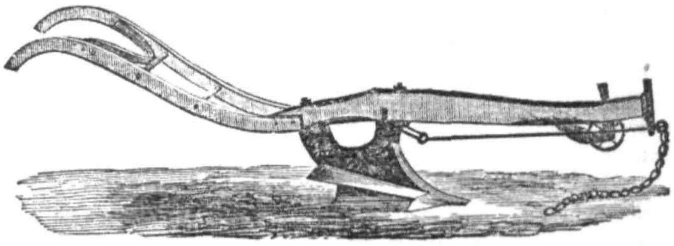
ERRONEOUS THEORY REFUTED.

393. B. T. HARVEY says: "Organic matter, lying upon the surface of the soil, unmixed or uncovered with any other absorbing element, in a state of decomposition, may "waste its sweetness on the desert air," or, in other words, its fertilizing properties may escape in a gaseous form. But in all ordinary cases, the organized matter in the soil undergoing decomposition, so far from being evaporated and lost in the atmosphere, is, on the contrary, absorbed and retained by the other elements constituting the basis of the soil. But if it were otherwise, it must be evident to all observing minds, that from November to April, throughout the Northern States, decomposition in the soil is arrested for want of heat; consequently no injury could result from fall plowing, so far as evaporation is concerned. But supposing the Doctor's opinion of evaporation correct (which neither facts or logic will establish), it is even then questionable whether fall plowing or plowing at any season will have a tendency to impoverish any soil of ordinary fertility. That there may be, as above stated, a continued passing off of fertilizing elements into the atmosphere, from organic matter in a state of decomposition, not in immediate contact with other absorbing elements, is evident, but which must again, through chemical attraction, or by combination with the humidity of the atmosphere, in connection with dew and rain, return to the soil. If this were not so, would not the air we breathe become surcharged with deleterious elements, producing death so rapidly that the M. D.'s themselves would soon become subjects. But experience has taught the farmer that frequent plowing and turning the soil is the proper way to fit it for attracting and retaining moisture, and why not fertilizing properties from the atmosphere as well. As there are some exceptions to general rules, so there are some soils that may be injured more than benefitted by autumn plowing; such as light sands, or soils wanting tenacity, by the operation of plowing,

and through the agency of frost, be rendered still more friable, and wanting in proper texture. In the cultivation of such soils, it is important that the roller should follow the plow. If, as a general rule, fall plowing has a tendency to deterioration, then plowing at any time must be injurious to land, and the less it is practised the better for the soil. This may be gratifying in theory, but it will be found ruinous in practice."

THE SUBSOIL PLOW.

394. The accompanying figure represents an implement called the "Lifting Subsoil Plow." The standard consists of a flat



SUBSOIL PLOW.

piece of iron an inch or more in thickness, with two heads on the upper part, by which it is bolted to the underside of the beam. The point or share is made either with a wing on both sides, like a spear placed flat on the ground, or with the wing only on one side, as shown by the illustration. On one or both sides of the standard there is an adjustable flange about three inches wide, over which the soil rises and drops back crumbled into the bottom of the furrow. The share and these flanges form an inclined plane. If it be desirable to elevate the soil much or only a little, the rear ends of the flanges may be adjusted to the desired height by means of bolts passing through the standard. The higher the rear ends of the flanges the harder a plow will draw, and the more thoroughly it will pulverize the soil. A draft rod and dial clevis attached to the beam enable the plowman to

so adjust it as to run directly in the furrow made by the common plow, thus breaking up the compact subsoil, and leaving it in the furrow. The wheel may be placed on either side of the beam. If the plow will not run deep enough loosen the standard bolts, and put a thick piece of leather between the forward standard and the beam. Or a better way will be to separate the beam from the standard, and dress off one-fourth of an inch of the under side of the beam, where it rests on the rear head of the standard. This will give the point more "pitch," so that it will run in readily.

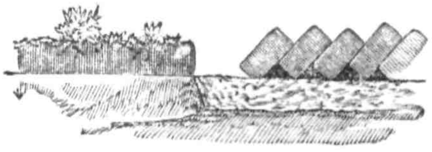
HOW TO SUBSOIL.

395. When a farmer has but one team, he plows one furrow round the field or land, and then hitching to the subsoil plow goes round again in the same track. In order to pulverize the subsoil very thoroughly, it is necessary to cut narrow furrow slices, and to use the subsoil plow when the ground is cross-plowed as well as the first plowing. Subsoiling thus for two or three years, the ground will be pretty well pulverized to the full depth the subsoil plow reaches. When the plow cuts wide furrow slices the subsoil plow may be run twice in the furrow. When this is not done, and especially if the field be subsoiled only one way, the subsoil will not be more than one-third or one-half broken up. A span of horses or yoke of oxen will draw a two-horse subsoil plow ten to fourteen inches deeper than the first cut through a pretty compact subsoil. When run deeper the draft increases very rapidly, and the pulverization is not so complete. Two or three spans of horses or yokes of oxen are usually required if the subsoil plow be put down 18 or 20 inches deep, as is not unfrequently done in preparing ground for orchards, vineyards, hop-yards, &c.

396. It is essential in subsoiling, in order to do the work well, to have a sharp point on the plow. As the point is driven through soil that is much more compact than the surface soil, the points will wear out much faster than on a common plow; and unless they are renewed as soon as they are worn so that

it will not enter readily, it will be difficult to run the plow of a uniform depth.

397. The accompanying illustration represents a section of sod ground after plowing with a subsoil plow. The subsoil is



SUBSOIL PLOWING.

pulverized beneath the furrow slices as low as the dark line from the edge of the unbroken ground towards the right hand. This represents the appearance of a section of ground as nearly as we are able to make it look on paper. As stated in a previous paragraph, the subsoil must be plowed with narrow slices, and cross-plowed, before it would be pulverized to a uniform depth. The narrower the furrows are the more thoroughly the work will be done, and the longer the subsoil will remain open and loose.

THE EFFECTS OF SUBSOILING.

398. Some writers have affirmed that "subsoiling promotes drainage." This is the tendency—and so it is the tendency of moonshine to promote the healthy growth of plants. If wet subsoil be plowed deep enough, we might say that it promotes drainage. But in order to accomplish anything appreciable or tangible, it would be necessary to pulverize the subsoil several feet deep. It is said, also, that "subsoiling lets in the air." Where there is not an excess of water in the soil it does; but where the ground is wet, and has not been underdrained, air cannot fill the interstices of the soil while they are full of water.

399. Subsoiling enables roots to strike deeper, providing they do not meet with a strata of soil that is full of water. Roots of a cereal crop will not spread in any soil where they are required to grow in water. Subsoiling promotes the absorption of moisture

from the atmosphere during drougths, thus enabling crops to withstand the effect of hot and dry weather. When a soil is thoroughly pulverized one or more feet deep, and there is not an excess of water, the warm air fills the interstices and is condensed, thus furnishing moisture for the roots. This condensation is effected in the same manner that we see water formed on cellar walls, or stones that are well bedded in the ground, or as dew is formed. There is aqueous vapor in the atmosphere, which comes in contact with the cold earth, and is condensed, thus forming water. Therefore if the soil be free from an excess of moisture, dew will be formed—not only on the surface of the ground—but in all the interstices of the soil where air enters freely.

400. If we subsoil a strip of land, and skip a land where the subsoil is very compact, or even not very open, and underdrain it where there is an excess of water, and plant Indian corn, it will be seen that the leaves of the corn where it was not subsoiled will be rolled up during hot weather, while that which had been subsoiled will look fresh and green, and the leaves will not be *rolled up until the weather becomes extremely dry.* These thoughts will be sufficient, it is believed, to convince intelligent farmers of the importance of using the subsoil plow where the subsoil is not already as open as it should be.

401. I have found the two-horse subsoil plow an excellent aid in cutting ditches, where they were wide enough for a horse to travel in them. Sometimes it was drawn by two horses, one on each side of the ditch, with a whiffletree some eight or nine feet long, and a chain three or four feet long from the whiffletree to the plow. When used in this manner, it operates as an excellent ditching plow.

402. Every observing farmer knows that when hollows have been filled up with mellow earth of any kind, two or more feet deep, heavy showers of rain are immediately absorbed, and the surface appears quite dry after a short time; and if more water falls than the soil will hold by capillary attraction, it settles at once beyond the reach of the roots of plants.

SUBSOILING WET GROUND.

403. When any kind of subsoil is not dry enough to crumble readily, running the subsoil plow through it will have little good effect, because it is pressed by the passage of the plow into a smaller compass; and as it does not crumble, it settles back very much to its former bed, occupying less space; and when the surface water is dried out, it becomes more compact than it was before the plow disturbed it. If the land be thoroughly underdrained before the subsoil is broken up, it will be crumbled and lightened up. Months must pass before the lumps will wash down so as to materially fill the interstices, and the subsoil will not become so compact in several years as it was before subsoiling. It is therefore of little or no use to subsoil wet, heavy soils before they have been well underdrained. For this reason, many farmers, on soil which is exceedingly wet, with the subsoil compact and retentive, have experimented with and condemned the subsoil plow. We have known subsoiling to be done when the water would be driven along in the furrows before the plow by the turning over of the furrow slice. The consequence was that the more the subsoil was worked the harder and more compact it became as soon as the water had dried away, and the more difficult it was for roots of plants to spread in it. As a natural consequence, such poor results had a tendency to bring subsoiling into disrepute. If the wet heavy soils be well underdrained, and subsoiled when just dry enough to crumble, good results will invariably follow, if the work be thoroughly done. This process on many farms would add several acres of ground available for increase of crops as certainly and with less cost than buying additional land. Better grow 80 bushels of corn on one acre than to plant and cultivate one and a half acres for the same crop.

SUBSOILING SKINNED LAND.

404 W. R. Coppock wrote to the *Genesee Farmer:* "Did you ever see "*skinned*" land? If not, I will explain the term. It is land that has been cropped for a long succession of years,

skin deep, or only a few inches in depth, and all the manure sold every spring to the person who would pay the most for it. Just such a place of twenty-five acres, beautifully located near our city (Buffalo), I have just purchased. My first step was to provide a span of horses and dung cart, with which three cords of fertilizing material were hauled daily and spread on the land previous to plowing. This material consisted of stable manure, ashes, limed hair, charcoal from the rectifiers, sweepings from smiths' shops, bones, old plaster, lime rubbish, and street dirt.

405. I then purchased a subsoil plow (similar to the one illustrated, Paragraph 454), and invited some twenty practical and amateur farmers, who had never seen a subsoil plow operate, to see it work. I turned a furrow slice with the common plow nine inches deep. The subsoil plow followed in the bottom of the furrow eight inches deeper, crumbling and rendering permeable and light, without bringing to the surface any of the inert hard-pan, and comminuting earth's rich inorganic materials that had lain dormant for ages past.

406. Here was the charm! My friends looked on with astonished delight. Conviction flashed on their minds, and they appeared quite satisfied of the great and important advantage that must result from pulverizing the earth deeper, thus affording greater space for the roots of plants to penetrate, and providing a safe-guard against the drought of the growing season. The land was left as light as a well-spaded bed or thoroughly-trenched garden. It was so well pulverized that the surface was raised ten or twelve inches above the level. (We think it would not have measured more than six inches. Earth must be pulverized exceedingly fine in order to make a depth of seventeen inches occupy twenty-seven inches deep.) Is not this the great fundamental step towards renovating my skinned farm?

407. A three-horse team drew the subsoil plow at the first, and afterwards a heavy yoke of oxen; and, with the exception of places where there was hard gravel subsoil or heavy clay, two horses drew it without severe fatigue."

COMBINED SURFACE AND SUBSOIL PLOWING.

408. In many parts of the country common plows have a "subsoil attachment" fastened to them, which consists of a spear-like head, similar to the lower part of a subsoil plow. It is attached to the beam of the main plow by iron bars, and works close behind it in the bottom of the furrow. It is adjustable, so that it can be made to run two or more inches deeper than the bottom of the furrow.

409. The manufacturers contend that with such a plow the subsoiling can be done at the same time, and with the same team required to draw the common plow. But this is not so. All the advantage that can be rightfully claimed is, one man can hold the plow for performing both kinds of work at the same time, whereas two men are required when two plows are used at the same time. It is the height of folly to talk about pulverizing our heavy, compact soils from twelve to twenty inches deep without a strong, heavy team. A plow may be constructed to work the soil to that depth which may be held by one man. This is the only source of economy. No man can plow deep without some strong force to draw his plow

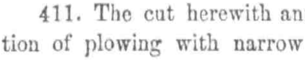
MANNER OF PLOWING LIGHT SOIL.

410. When plowing stubble of any kind, where the soil is light and of a mucky character, it is better to use a plow that will turn a wide slice. The furrow slice should have a short decided twist, be raised in turning, for the more effectual covering in of the stubble and other trash, and be turned quickly and strongly, so as to force the soil all over to an inverted position, breaking it fine in the act, and leaving a clean channel for the reception of the next furrow. This is the kind of stubble plowing you want for light soils. I have seen stubble plows at work of such construction—raising the earth so high, turning it so forcibly, and withal in such a sort of spray from the rear of the mould board, that you might lay down a full-sized bundle of straw or stalks, and, passing by it with the plow, cover it entirely

out of sight with a single furrow. You can readily see that the long, gradual, easy twist of the green sward furrow slice is not adapted to good stubble plowing, nor is the short abrupt twist of the stubble furrow slice at all suitable for easy, handsome and effective green-sward plowing. Each requires its own peculiar form of plow to produce the best effect.

PLOWING HEAVY SOILS IN STUBBLE.

411. The cut herewith annexed represents a transverse section of plowing with narrow slices, as directed in a previous paragraph where the soil is heavy, and not in sod. This kind of plowing is done with a deep tiller plow, similar to Mead's Conical Plow or Allen's Cylinder Plow, Paragraphs 451 and 454. It will be seen that the entire soil is broken up and well pulverized, so that plants will find little difficulty in sending their roots in all directions through it. All good plowing appears similar to this when examined with a spade. But where furrow slices are wide, and the plow runs deep sometimes, and at others shallow, and the point dull, and plowman lazy, there will be many unbroken bars or ridges beneath the surface which the roots of growing crops cannot enter without much difficulty. Some of my fields, where there were many Canada thistles, were plowed in this way with deep narrow slices in hot weather, soon after a crop of oats or wheat had been removed; and when the weather continued dry, the thistles gave very little trouble the next year, as all the roots were killed as deep as the plow ran.



DEEP PLOWING.

FROST AND RAIN GREAT PULVERIZERS.

412. After a soil has been broken up it soon commences to run together again, and to set very much as mortar does, which has been made of lime and sand; and to assume a solid and almost organized form. In this process, almost every particle of the soil that has been plowed is moved, more or less; and much

of the soil is separated and moved several inches from those parts with which it has been in contact. This operation is effected by rain and sunshine. As a matter of course, this change in the position of the particles of the entire soil does much towards securing thorough pulverization. Freezing and thawing of a soil exerts a very important influence in securing the complete pulverization of all soils. But when a soil has been plowed several months before the time of frost, it becomes consolidated; and the frost will not exert half the influence, in its more thorough pulverization, that it would were it but recently plowed.

413. For this reason, plowing early in autumn—where thorough pulverization is the chief object—will not be as effectual as late plowing, or even plowing in the winter. If the rains and frosts of winter can be in operation when a soil is running together, after it has been plowed, the pulverization will be more thorough and complete than it would be under any other circumstances. And more than this, the more complete the pulverization is the longer that soil will remain mellow and porous; and consequently the greater will be the available amount of fertilizing matter in that soil which will promote the growth of crops.

THE WAY TO PLOW WET GROUND IN THE FALL.

414. As farmers cannot complete all their underdrains in one year, nor usually in ten years, there is a mode of plowing wet fields in autumn which will improve very much the friability of the soil, and thus be the means of producing a much larger and better crop the next season than when plowing is performed in the usual way. The first consideration is to lay out the lands for plowing, up and down the slope, as nearly as may be. The slope is sometimes in a diagonal direction across the field, and sometimes a field does not all slope in one direction. But where the ground is decidedly wet, the lands should be up and down the slope, if the inclination is not so great as to wash away much of the soil, so that the middle furrows may carry off the surplus water more readily than when made *across* the slope.

415. When wet land is plowed *across* the slope in late autumn

the surplus water will be retained, in a great measure, by settling across the lands, from one middle furrow towards another, by which the soil will be kept well saturated, and sometimes completely flooded with water. In case a field should slope gradually from two directions, and form a shallow valley, the true way would be to plow a land in the lowest part of the valley, and then let the middle furrows of all the lands, up and down the slope or slopes, empty into the main middle furrow.

416. Now that the work is laid out, the next step will be to execute it. If the ground is sod ground, the plowing should be performed—if it be done with a single plow—with lapped furrow slices, and not with the furrow slices laid flat. And more than this, the plowing should be done in narrow lands—not more than sixteen or eighteen feet in width. Then, after every land has been finished, adjust the plow for running as deep as the team can draw it, and cut the middle furrows six or eight inches deeper than the rest of the plowing. After this has been done let the middle furrows be shoveled out, so as to form a free channel for the water, and let the earth which is shoveled out be spread evenly each way from the middle furrows, over the ridges. One active man, with a good round-pointed shovel, will shovel out a long line of such furrows in a day; and the good effect upon the crops next season, where wet land is treated in this manner, will amply remunerate for the labor bestowed. This kind of work can be performed when the weather is so unfavorable and cold that workmen can do little or nothing else to good advantage

LAPPED FURROW SLICES FOR HEAVY SOIL.

417. Plowing heavy soils with flat furrow slices in late autumn is decidedly objectionable, because the soil is not efficiently pulverized. Generally speaking, when furrows are turned flat, the cohesion of the soil is not half broken up; and although the furrow may appear to be broken up, as it turns on the plow, still all the cracks will close after the furrow slice leaves the plow; and the soil will be but little better, so far as its porosity is concerned, than if it had not been plowed. Simply inverting

the soil to the depth of five or six inches in one unbroken mass, as we would turn over a plank, thinking that the rains and frost will render it sufficiently porous and friable, is a wrong idea. The plow must not only turn the furrow upside down, but it should destroy entirely the square form and unbroken compactness of the furrow slice. Then the rain and frost will be able to effect its pulverization in the most desirable and perfect manner. By plowing with a plow that turns round or convex furrow slices, the ground is prepared for the rain and frost to perform their office. By plowing with lap or flat furrows, we leave a task for the frost and rain which they are unable to perform, which the plow should have done, and then wonder why the result should be so different from what we anticipated. By turning the furrow with a plow that rolls a thin sod together, and encircles it completely with well-pulverized supersoil and subsoil on all sides to the depth of three or four inches, the soil is prepared in the most perfect manner possible for rain and frost to perform their work, and to preclude the risk of the elements of fertility being washed away by drenching rains.

HOW TO BECOME A GOOD PLOWMAN.

"To tend the flocks and herds, and break the soil,
And reap the golden grain, is pleasant toil."—EDWARDS.

418. It is with plowing as with any other work. If a man is ambitious, energetic, and prompted with laudable aspirations to excel in his business, he will undoubtedly succeed. On the contrary, if he is indifferent, and satisfied when he plows well, and not dissatisfied when he plows badly, he will not make an expert plowman. A good share of ambition is essential. An easy-kind-of-a-nobody may get up ambition enough to admire good plowing, when stimulated by others to praise it; but his own plowing will be performed, like every other job that is performed, in a second or third-rate manner.

419. If a man or boy desires to excel in the art of plowing, he must learn first how to hitch the team correctly to the plow, and how to adjust it, in order to make it run deep or shallow, to

the right hand or the left. He needs to learn by practice that when the traces are lengthened or shortened only one, two, or three inches, or when the draught is changed at the end of the plow beam only half an inch, the running of the plow will be altered so much as to prevent doing the work well. Observe closely the movements of the plow. See how it does the work when running at a given depth and width of furrow slice. When the soil is variable, and it appears difficult to cut a furrow of uniform width and depth, observe those places where the plow works to suit you. Then stop at once, and endeavor to adjust the plow by the clevis, by the wheel or wheels, by lengthening or shortening the whiffletrees or traces, or ox yoke and chain, to make it run exactly the depth and width desired. Make yourself master of the principles laid down in Vol. I., pp. 331 to 336, on Adjusting the Plow and Beginning to Plow, and procure plows adapted to the work—*to the depth of furrow and width of furrow slice*—and you may safely calculate on a very satisfactory improvement in plowing. But the beginner must keep in mind this one important fact, that he cannot plow well eight inches deep with a *plow that was designed to run only four inches deep. A deep* tiller plow will work well when running shallow; but a shallow tiller will not do good work when adjusted to run deep.

420. Plowing is quite different from most other work. If it be poorly performed it must remain so. A plowman cannot return to perfect a bad job. When hoeing potatoes, he can return and do his work over again until it is well done. But in order to plow well, a man must know how to start correctly, and how to maintain a correct course of procedure. A careless, inadvertent step in the course of one's conduct brings a reproach on his character that cannot be easily wiped away. So with plowing. If every furrow is not made with careful precision the work will not be done well. These suggestions are made merely to induce young plowmen to aim to excel in holding the plow. Good plowing is intimately connected with "paying farming;" because if land be not well plowed it is folly to expect to raise superior crops. And if a farmer fails to grow remunerating

crops because his land is not half pulverized, he cannot expect to make farming pay. If we can induce our farmers to plow better, one very important step has been taken towards making the cultivation of the soil a paying business.

DRAUGHT OF HEAVY AND LIGHT PLOWS.

421. The momentum of a plow in its passage through the soil is not an appreciable force. There is no advantage arising from the use of a heavy plow, from its relieving the team in overcoming obstacles. On the contrary, there is considerable disadvantage in the draught of a heavy plow, as every unnecessary pound absorbs a certain proportion of the effective muscular force of the team. If a plow weighing one hundred pounds, which is heavier than many good plows, be sufficiently strong, the addition to its weight of thirty or more pounds will tax the team to haul that unnecessary weight from day to day to no purpose. A dynamometer (or draft-measurer) is not delicate enough to indicate the difference which there actually is between the draught of light and heavy plows. If a plow cuts a furrow slice one foot wide, then in plowing one acre, if it weigh thirty pounds more than is necessary, it will absorb an amount of the effective force of a team sufficient to move 1,980 lbs. a distance of one-eighth of a mile, dragging it along on the ground. These facts lead us to discourage the use of unnecessarily heavy plows, out of regard to the teams, if not to the plowman.

422. In plowing stony soils with a light plow, if small stones continually turn the plow from its course, so that the plowman must labor hard to keep it in its proper place, I have often seen them put a large stone in the bosom of the plow to make it run more steadily, and I have sometimes done so myself. In such places there is some advantage in a heavy plow. Still, as a general rule, a heavy plow will be found about as disadvantageous as a heavy shovel, heavy hand hoe, chopping ax, grass scythe, or grain cradle. If a plow be made sufficiently strong it will be heavy enough to work well in most soils.

HOW TO TEST THE DRAUGHT OF PLOWS.

423. An instrument called a dynamometer is placed between the plow beam and draught chain, and the team draws by it as by a clevis. They are required to move at the rate of $2\frac{1}{2}$ miles per hour, or 220 feet per minute. The dial and index of this instrument is graduated to represent a horse power when the team moves at the velocity just stated. For example—if the dynamometer indicates 300 pounds when the team is moving at the rate of 220 feet per minute, the force required is just equal to what is understood in mechanics as "two-horse power." Now, if the speed of the team be increased from 220 feet per minute to 440 feet, or 5 miles per hour, the dynamometer will indicate 600 pounds instead of 300. This is the theory, and is probably correct.

424. When a man desires to have the dynamometer exhibit a light draught of his plow, he adjusts it to run at the desired depth, without drawing downward but very little on the gauge wheel at the end of the beam. Then he drives the team as slowly as he can make them move, and at the same time lifts on his plow handles and thrusts forward, as if he was shoving the plow by hand. In this way the draught of a plow will be exhibited by the dynamometer much less than the correct draught. On the contrary, if he desires to make it appear that some other plow draws harder than his own, he will adjust it to run a little too deep, then bear down heavily on the handles, which increases the draught, and drive the team much faster than 220 feet per minute, when the dynamometer will leave the 300 pound figure and stand at 400 or 450 pounds.

425. The theory is that a certain amount of force is required to draw a plow 220 feet per minute. Now, if that resistance and friction in cutting the furrow slice loose and turning it over be overcome in less time, the force must be increased.

DON'T PLOW HEAVY SOILS TOO EARLY IN THE SPRING.

426. By too early, I mean before the soil has settled or is in a proper condition to turn up mellow and lively. Ground should

always be allowed to *settle* after it has been frozen before it is plowed. The soil is rendered lighter and more porous by freezing and thawing; and after it has been frozen and thawed it settles back to its original compactness. Therefore if it be plowed before it has settled, it will settle *after* plowing; and in a short period of time will be as compact as if it had not been plowed at all. But let it be plowed or spaded after it has settled to its former compactness, and it will remain mellow and friable for a long time unless it is excessively wet.

427. Every farmer should make some estimate of his plowing and sowing, in order to know how many days will be required to complete this branch of business; and then, if the weather is unfavorable and the soil too wet, plowing may be delayed sometimes for a longer time, or until the soil is in a proper condition to be plowed and harrowed. These considerations are of far more importance where clay predominates in the soil than where the soil is sandy and loamy. As soon as the frost has disappeared from the soil, and it has settled and become so dry that it will not adhere to one's feet, it is in a good condition to be plowed, as it will pulverize more thoroughly if plowed about that time, than it will if it be plowed before it has settled. Where soils are apt to become lumpy, or to bake, it is very important that they should be plowed at a time when they are just moist enough to crumble well when the plow breaks them up.

428. In case a field is inclined to be a little too wet, it would be far better, both for the soil and the crop, to defer plowing it for a week or more than to plow it early, when the furrows roll up like huge slabs of putty. Ground may be plowed for Indian corn during this month, in some localities, more advantageously than next month; although, as a general rule, it will be best to defer plowing for that crop until the time to plant the seed has nearly arrived. Where the soil is heavy and in sod, and free from noxious weeds, let it be plowed as soon as practicable after the frost has disappeared from the ground. Many of the fields on the slopes of our lakes, where the soil is heavy, ought to be plowed as early as practicable in the spring, because the work

can be performed so much better—the furrows can be cut of a more uniform depth, and the soil will pulverize better—than it would if the plowing were deferred until later in the season.

429. When the soil is light, mucky, sandy, or gravelly, plowing may be done at almost any period. But it is far better to let teams stand idle, and plowmen do nothing, than to plow heavy soils too early in the spring, when a spring crop is to be put in without plowing a second time. I am familiar with many kinds of soil that may be plowed with decided benefit as soon as the frost is out, before it has settled, if it is to be plowed again before seed time. I will mention instances in point, and the advantage. On the slopes of many of our lakes, where there is a large proportion of gravelly, calcareous clay, if it be plowed before it settles it will turn up mellow—if there is not an excess of water—and the plow can be run at a more uniform depth than if the soil had settled. Then, just before the crop is put in, plow again. I have always observed that soils of this character, when managed in this way, would continue mellow much longer, and produce better crops than when plowed but once either early or late in the spring.

ABOUT TEMPERING PLOW IRONS.

430. The ignorance and credulity of farmers are often imposed upon in the most outrageous manner by blacksmiths, who temper plow coulters and steel points, as well as by manufacturers who make cast-iron shares. In the 1st vol., p. 325, I discussed the merits of cast-iron points. Here I shall expatiate on steel points.

431. Some manufacturers use a very poor quality of American steel on points on their steel plows, and give them a low temper also. Consequently the points wear out almost as soon as if they were made of wrought iron. No plow will run well with a dull point except in very soft ground. Furthermore, when plow points are resharpened with poor steel, and not tempered properly, it becomes necessary to sharpen them quite often, which is somewhat expensive. Cast-iron plow points, if made of hard iron, with the

edges cold-chilled, as directed, Vol. I., p. 325, will wear better and be less expensive than steel. But when a farmer has concluded to use steel points, he should procure good English Blister, and have the blacksmith use charcoal instead of mineral coal for heating it, and stand by him and see that he gives it a hard temper. (See How to Temper Edge Tools, Vol. I., p. 371.) The correct temper for a plow point and coulter is as hard as a stone-cutter's tools for drilling and dressing granite. Then they will wear well. A man can temper such things himself by following the directions in Vol. I., 532. A sky-blue temper is too soft for plow points. It should be of a straw color, and if a point is rather thick, the color may be a little higher than straw color—merging into white, or the lightest color.

432. The reason why charcoal is superior to mineral coal for heating steel is, it does not furnish so intense heat as mineral coal, as the latter will often burn steel before it is sufficiently heated through and through. A charcoal fire heats thick pieces of steel gradually without burning the surface. Put a plow coulter or point in the cook stove, when blacksmiths are at a distance, and as soon as it exhibits a *red* heat plunge it into cold water till cool. Apply a file to it, and if the file cuts it, heat it a little hotter, and cool as before. Some steel requires more heat than others. Therefore if the temper is not right, heat the steel again and cool it until it is hard enough.

BREAKING PRAIRIE.

"Now, the strong plow, among the jagged roots,
Oft stalled with difficulty, turns beneath
The black and antique mould." READ'S NEW PASTORAL.

433. The chief point of difference between pioneers of our western world, with reference to breaking prairie, is the *time when* it is best to plow, and the *most suitable depth.* One man contends that it is best to use a strong team and plow deep; while another, whose authority is equally good, maintains that it is better to plow shallow. My own opinion on this subject is, that when prairie is broken in the spring, and a crop is to be raised

on it immediately, shallow plowing is best, because the grass is speedily killed at the top, and the lower roots are smothered. If, after taking a summer corn crop from this, it is turned deep under, the new soil brought up is ameliorated by winter freezing, and is then ready for spring crop. If the deeper new soil that has long lain below the free access of air be turned up and planted to corn, it will not do well. If plowed deep in early summer, and left thus, it will be moderately fitted for autumn or spring wheat, and the slowly decaying sod beneath will furnish a good seed bed as well as food for the wheat roots. We should therefore say, that the question depends very much upon the *relative* importance of the first season's corn crop as compared with that of the following wheat crop. If a good yield of corn is imperatively necessary to a new settler, let him break shallow at first and deeper afterward. If he can wait for the wheat, and also to get the best possible *future* condition of the soil, let him at once mix the surface sod with the lower soil, some of it at least as deeply as possible.

434. A correspondent of the *American Agriculturist*, who professes to have had much experience, says: "Breaking prairie is a work accompanying pioneer life, and as oxen are the best teams for pioneers, they are best to break up prairies. Horses, to do much at the business, must have a good supply of grain or they will run down, and grain is a costly article with pioneers, while prairie grass is most abundant. Strong ox teams may be *hurried* throughout the proper season of breaking (say from fifty to sixty days, commencing as soon as there is a full bite of grass for the teams) and yet increase in flesh. I have broken 15 acres by the week, with five and six yoke, without reducing the condition of my team. To do a first-rate business at breaking in timber lands or "barrens," much of the team should have horns, because in all such places the plow should go as near a foot deep as possible. Two pioneers being neighbors, and having between them four yoke of good cattle and some steers, may unite their forces, and break more and far better, with such a team, and the *right kind of a plow*, than three men, each plowing with a span of horses, would be at all likely to break. Some dozen years ago

I remarked to a friend, who was breaking in "the barrens," with rather a light team, that he had better increase his team, so as to break his ground fully twice as deep. After debating the question at length, he added six head to his team, and broke accordingly. Several years afterwards, that friend assured me that the line where the depth of breaking was doubled, had been manifest in every crop he had grown upon it since.

435. Experience and observation justify me in saying to all who can open farms, where the soil and climate are similar to that of Illinois, *break or plow all the rich loams at least one foot deep.* This is imperative, if they would grow abundant crops of corn. No good farmer should aim at less than 70 or 80 bushels to the acre, which is more than twice what Illinois farmers commonly get. If any one will manage his corn field "first rate" in all respects, I will add 20 bushels to the above, as what he may reasonably aim to secure without using a hoe after planting. Such plowing will also very much increase the yield of most of other crops, small grains and grass. In light, sandy soils, turning up the ground 12 inches deep, might not only fail to pay well, but might be in some cases deleterious on account of letting fertilizers sink too deep into the ground. Let me further say to the pioneer who is constrained to break shallow, and as late as in the month of June, to grow a crop of sod corn: Get for seed either Canada flint, Rhode Island premium, squaw corn, or some kind which will mature in sixty days. I have put out such as I got from the Indians, called squaw corn. The ground was broken as late as the 12th of June, less than two inches deep, and the yield was very good. It ripened fully in August. Still, had July and August of that year been as dry as those months often are, it is not likely I should have got my seed back. Twenty years ago I deemed that the best breaking which was the shallowest, and boasted that I could cut and cover at less depth than two inches. Even *now*, I have no doubt this depth is about right for the *special* purpose of putting in a crop of *wheat* the same season, before the autumnal equinox. Yet even then, I thought it well to go three or four times as deep in

cross-plowing the ground for corn." John E. Darby, Muscatine Co., Iowa, writes: "The first point of importance is the *season of the year* for breaking, this may vary slightly in different years, but as a general rule, the very best is the month of June. The operation may be commenced as soon as the young grass is sufficiently started for pasturage, and be continued until harvest. This gives a range of time from the middle of May until the middle of July. If done earlier, weeds sprout up through the sod; the grass also comes up, and renders it tough to work the next year. If later, the sod does not rot sufficiently for wheat, though it generally lies clean and brings good corn. I can see no difference in the rotting, whether left smooth or rough; but it is far pleasanter working smooth; and a plow laying a smooth furrow runs lighter. New sod is good for almost any field crop, and gives the surest chance for spring wheat, which is never or rarely injured by chinch-bug or rust, and less liable to smut. Wheat is sown on the sod as soon as possible in the spring, always without stirring, but thoroughly harrowing, which is easily done if the sod has been properly broken, and at the right time. For corn, the sod must be re-plowed in the spring. This is easily done, if the sod is well rotted, and it generally will be if broken in June; but if the sod is a little tough or raw, a rolling cutter is of great use. Plow an inch or two deeper than the breaking, and proceed as on sward in the east. Another thing of importance is, to break as shallow as possible; 2½ to 3 inches is sufficient, the sod rolling better than when broken deep. In "roughs" or bushy land, it must necessarily be broken deeper. Another point is, to have the land freshly burned, if possible; mark it off, burn the old grass, and break immediately. If the grass gets too high, the sod does not rot so well.

436. "A word as to mode. Breaking prairie was formerly almost exclusively done with ox teams, from 3 to 6 yokes to a plow, the plow cutting from 18 to 28 inches. This made it necessary to employ regular 'breakers,' as not every one could afford to keep such a team; but now, smooth prairie is frequently broken with two or three good horses—if three, worked abreast

A plow of 10 to 12 inches cut, and of sharp wedge-like form, is used, and some prefer this kind of breaking. I have done considerable in this way, and with two medium horses can break from 1 to 3 acres per day. A poor man can thus make a farm with little expense beyond his own labor."

437. Mr. JOHN W. BARRETT, Pierce Co., Wisconsin, writes: "The best time, or I might say the only time to break up prairie land, is from the 1st day of June to the 20th of July. The reason is, that broken before June, the grass does not get a good start, and it will turn and grow through the breaking. If it is June and July, the grass has a start, and when breaking is done with a hot sun on it, is sure to rot. Have the sod all turned over, and let it be as rough as possible to make it, as when in this condition it is more easily torn up and prepared for seed harrowing in the spring. Wheat is preferable for the first crop, and also for the second. My own practice is to break my land in June, then sow turnips or ruta baga seed, which usually pays for the breaking. The following spring I use a large cultivator, dragging it over twice again, which is sufficient if the land is broken at the right time. The sod rots better when rough than when laid smooth and even."

438. "Why will not 'wild' prairie sod rot like that of 'tame' grasses at the west and east?" is a question we repeatedly asked, and received the response that the roots of wild grasses and weeds are so tenacious of life that they cannot be effectually killed and the sods made to decay if turned under deep. In opposition to this view we have a single fact to present, and our prairie readers may draw their own conclusions. Mr. THEODORE GENNERT, of Livingston County, Illinois, plowed the land for his beets and for a considerable corn-field to the depth of 10 or 12 inches, the latter being reached whenever practicable. Double Michigan plows were used, and the top paring of sod was covered with 9 inches of mould. Mr. G.'s beets were the only good field crop we saw in Northern Illinois in October, and his corn, though "sod corn," and somewhat damaged by the frost, was by far better than any corn raised on old land which we saw in that

region. It stood the drought well, and a large portion of the crop was so far matured as to be uninjured by the frosts of August and September.

WIDE *vs.* NARROW FURROW SLICES.

439. Every good plowman knows that it requires sometimes twice the amount of force to draw a plow to cut the first furow than is necessary after one furrow has been made. The reason of this is, the first slice must be cut out of the solid ground, and the whole of it raised as high as the plow runs in depth; and the side pressure on the land side and mould board, besides the friction arising from other sources, is sometimes equal to the power of one horse. This is especially true when turning the first furrow slice in sod ground that is hard and dry. The writer has often been obliged to run the plow three times across the field in one place, before one furrow could be made of the desired depth. This was because the ground was so hard and dry, a team could draw the plow only a few inches deep. But after one furrow was made, the team could cut a furrow the desired depth with comparative ease, by adjusting the plow to take a slice only a few inches wide. When a plow cuts a wide furrow slice, the draught is increased with the width, until the same amount of force is required that is essential to plow the first furrow through unbroken ground. For this reason, when the ground is hard and dry, unless a plow is set to cut very narrow slices, more team must be employed. But by using a short ox yoke, or a short double whiffletree, so that the plow may be made to cut only four or six inches wide, and by having a sharp coulter on the plow set as far back towards the throat or standard of the plow as it can be conveniently, a single team can plow hard and dry ground as deep as a double team, but not so fast. Still, the pulverization would be much more complete. When a double team is employed to plow hard and dry ground, if there is only a limited proportion of clay in it, the slices will frequently turn up in large clods, and require much rolling and harrowing to pulverize them. But by using a good coulter, set back of the

plow point, and plowing about one third of an acre per day, the work may be performed of a uniform depth; and the pulverization will be more complete than if the same soil were spaded. If the coulter be placed forward of the plow point, as it usually is for ordinary plowing, it will keep the plow from entering the hard ground readily. The plow point should enter three or four inches first, so as to make the plow run steadily. If the coulter be sharp, and in the correct position, it will shave off and pulverize a few inches in width more effectually than the plow alone. We have known farmers to plow heavy dry soils in this manner ten and twelve inches deep, cutting slices only three inches wide, with a single team.

POOR PLOWING IN AMERICA.

440. The first thought of a good farmer from Europe, when he sees how we plow in America, is, "what wretched work !" A Canadian farmer attending one of our State Fairs went to the plowing match with a view of witnessing a specimen of nice work; and the prize plowing was so much inferior to the ordinary plowing where he had resided, that he exclaimed with no little astonishment: "You don't call that premium plowing ?"

441. It is a shameful reproach to American farmers that they are such poor plowmen. For the most part, the plowing is performed in a most shabby manner. If the plow runs in nearly beam deep, or only two inches deep, or if it cut a wide or narrow furrow slice, it is all the same. And if they are as crooked as a doubled-and-twisted ram's horn—"all right. Crops will grow just as well as if every furrow were as straight as a mathematical line." This is the reasoning of American farmers, as a class.

442. Some of the reasons why we see so much poor plowing in America are, the plowmen possess little skill and no ambition to excel in performing a piece of work in a neat and thorough manner. This is the main reason Another reason is, the surface of the soil is left so rough and uneven, that it is impracticable for a good plowman to do the work well. Furthermore, many plows are not at all adapted to the kind of plowing; are

not properly adjusted; the team is not hitched right to them; and they are seldom in good running order. All these imperfections operating together *against* good plowing, are the means of performing the work in a very unskillful, and many times inefficient manner.

THE ORIGINAL FORM OF THE PLOW.

443. The shape of the mould board has elicited much discussion on the part of manufacturers. The original form of the plow was such as to simply loosen a few inches in depth of a portion of the surface, without any reference to inverting the sod. Then the thought was conceived of a form of plow that would not only break up, but move the entire soil just as it would be if a plow were to simply slide the furrow slices sidewise without turning them over. After this a piece of hard wood was dressed out in the form of a mould board, and attached to the wooden block, which subserved the use of the land side, and both were covered with narrow plates of iron; but sometimes there was no iron at all on the mould board. As the mould board was made of hard wood, having but little twist, it would last many years, as there was not much friction between it and the furrow slice. Specimens of this kind of plow are preserved in the New York State Agricultural Hall, at Albany. The standard of this wooden plow consisted of a strip of tough, hard wood, about four or five inches wide and an inch and a quarter thick, passing through the beam and the block of wood for the land side, with a strong iron bolt forward of it. The point of this style of plows was laid with steel, and I have often heard plowmen remark that the point was taken every day, while the team was eating, sometimes three miles to the blacksmith's shop to be sharpened. With such rude implements as this our fathers plowed the soil for crops.

THE PEACOCK PLOW.

444. Yankee invention soon supplanted the wooden plow alluded to in the preceding paragraph, by introducing an iron plow having a mould board and landside of thick land iron hammered

out in a very rude manner. Farmers looked upon this plow, when compared with the wooden "Bull Plow," as the height of perfectibility in this kind of implement. The standard of this plow consisted of a strong iron bolt, passing through ears or flanges on the mould board and landside, and up through the beam, with a nut on the upper end above the beam. Such plows were used only where the fields were free from obstructions, such as stumps, fast stones, and strong roots.

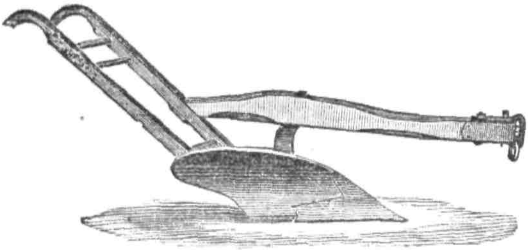
WOOD'S IMPROVEMENT.

445. I have often heard it remarked that Jethro Wood was a "whittling Yankee." He would whittle potatoes hour after hour in the form of miniature plows. At length he disclosed the idea of having a cast iron mould board and cast-iron standard in one unbroken piece of metal. His potato plow showed our improved plows in embryo. It was one of the best inventions ever made. It would be interesting to read the difficulties he encountered, and the obstacles he surmounted, in getting his patterns made; and, after they were made, how he persevered against a torrent of opposition to get them moulded and cast. Sometimes he found it necessary to give the moulders a *bonus* before he could induce them to *attempt* to mould them. Moulders, at that time, did not possess that degree of skill which is now manifested. Now mechanics can mould and cast almost any form. Then, if a man could mould patterns as straight as sleigh shoes, he thought himself "wondrous smart." The cast-iron standard was Mr. Wood's invention, and secured to him by Letters Patent.

HUTCHINSON'S IMPROVEMENT.

446. Mathias Hutchinson, Genoa, Cayuga Co., N. Y., in about 1855 brought out a plow with the cast-iron standard and landside in one whole piece, as represented by the accompanying illustration. The excellence of this invention consists in having a large, open throat, which effectually prevents clogging. I have used one of this kind of plow on my own farm, and I liked it very much. When plowing under coarse manure we would

often approach a lot of stubble and straw, which, one would think, would surely clog the plow, but it would always slip one

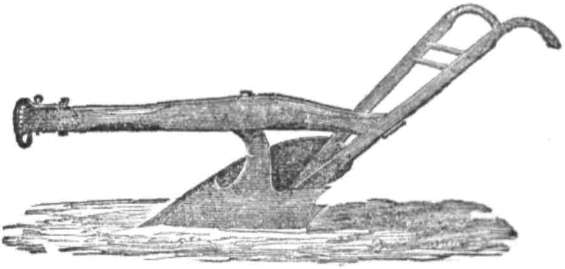


A MOULD-BOARD VIEW OF HUTCHINSON'S PLOW.

side as soon as the plow began to feel it. I never met with a plow that would run deep and shallow, cut narrow and wide, turn sod and stubble, without carrying earth on the mould board, and perform work as well as this plow. Still there may be better plows than this. I witnessed its operation at a plowing match at Auburn, N. Y., in 1862. I was chairman of the committee. We selected a hard, calcareous, stony soil, where a plowman would often be taken clear from the ground by the jostling of the plow. Some of the plowmen "backed out" after they had commenced. A celebrated steel plow, working on the next land to this plow, did very satisfactory work. But HUTCHINSON'S plow surpassed everything on the ground, and plowed its assigned task in a most superior manner. I have no pecuniary interest at stake which induces me to commend this plow. The inventor says in a private letter to me, which I take the liberty to insert here: "No patent has ever been issued on said improvements. The inventor desires them to be *free to all.* A caveat was filed and model sent to the Patent Office in 1855. Said plow was intended for deep plowing in sward land. Five years afterwards he made a plow of all work, intended to turn stubble as well as sward. This is not so long, spreads wider, and is lighter than the first pattern. The mould board is constructed on the principle of the screw and wedge combined. The forward part approaches the form of the

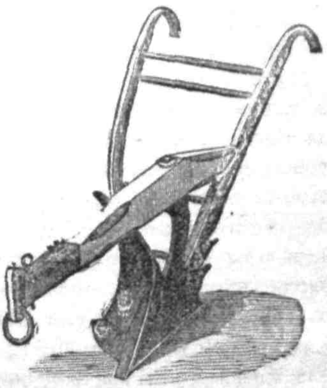
wedge, and rises and spreads at nearly the same angle; but the greater part is a section of a screw, slightly increasing towards the extreme wing.

447. One distinguishing feature of this plow is, the attachment of the standard to the land side, as represented in the cut,



LANDSIDE VIEW OF HUTCHINSON'S PLOW.

which prevents it from being choked out of the ground by stubble. It is of light draft, and is easily guided in proportion to the amount of ground it moves. It breaks the furrow less than some plows, and carries no dirt on the mould board, even in mucky ground, after being scoured smooth. This, however, is the testimony of those who have used it most. Being long and "clipper built," it is well adapted to turning a deep furrow in stiff clayey lands. The edge, including the point, is nearly twenty inches long, and cuts, when new, over twelve inches wide. This is useful in cutting off Canada thistle, clover, and other deep



FRONT VIEW OF HUTCHINSON'S PLOW.

roots, as it lessens the draft of the plow and assists in turning the

furrow in sward, it being more easy to cut than to tear off the bottom of the furrow slice, especially when full of roots." The inventor, M. HUTCHINSON, King's Ferry, P. O., Cayuga Co., N.Y., has been accustomed to forward a set of castings to be fitted up for patterns, to any one who desires to manufacture this kind of plow.

THE BEST FORM OF PLOW FOR HEAVY SOILS.

448. The *Mark Lane Express* suggests, by way of interrogatory, how is it that the round, ragged, shapeless furrow-slice produces a finer crop than the finely-formed rectangular one? How is the fact to be accounted for, that the squeezed sod is less fertile than the one whose appearance is less promising, in the estimation of amateurs, whose knowledge is more confined to book routine than the results of seed time and harvest? And since the fertility of the land is more a chemical than a mechanical question, how, again, on the other hand, do we account for the opposite result—that the sod which gets the greatest amount of shaking, breaking, frittering, and mechanical teasing, yields the largest amount of the best quality of corn? In fine, as two questions are obviously involved, and, therefore, are raised for solution, viz., a chemical proposition and a mechanical one, what is the peculiar relation that exists between them? If it be the fact that the primary object of cultivation for the production of the various agricultural crops is a well pulverized soil and porous subsoil, then the farmers ought to draw out the ingenuity of our agricultural mechanics by giving prizes for those plows that will invert without smoothing and smearing the under strata, and most effectually pulverize the greatest quantity of land a given depth with the least amount of power, instead, as the present practice is by all our agricultural societies, awarding prizes to those plows that cut out a furrow with all three of its cut sides well smoothed and smeared up, and turned over in as unbroken a state as possible, so that it will shine from one end to the other, like a well-moulded piece of concrete, and the bottom of the furrow well polished by the friction of a broad soled landside and

wrest, thus rendering the under strata almost impervious to air or water. If we could have a plow so made that it would, in the act of inverting the furrow slice, break it into pieces, and pass over the bottom of the furrow without the friction of any smooth surface of iron or other material being drawn over, closing up all the pores and fissures in the under strata, I think there is little doubt but such a plow's cultivation would approach (when performed at equal depths) fork cultivation. There are a great many of the best farmers who are of opinion that it is a great advantage to have the furrows turned as completely over as possible. But the great evil is, that when the plow is set to turn the furrow thus, they require so much harrowing to prepare the land for the dibble or the drill; but such would not be the case if we had plows that, in the act of turning over the furrow, would well crack, rend, and break it, and completely invert it, and cut it up from the under strata without smoothing the bottom of the furrow, and closing all the pores and fissures."

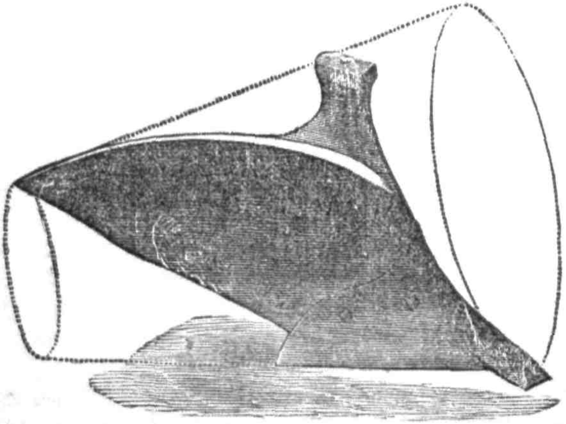
449. Returning to the first proposition, all the interrogations may be answered by the remarks in paragraph 320. The *mechanical* operation must always precede the *chemical*. The chemical is, in a great degree, dependent on the mechanical. Consequently, if the mechanical part be poorly performed, it is impossible for the elements of nature to complete the chemical portion.

450. Taking a philosophical view of the operation of plowing, the mind dwells on three distinct points, viz.:—cutting the furrow slice loose, turning it over, and pulverizing it. The great proportion of power is consumed in cutting the slices loose, not only on the side, but the bottom of the slice. After it is cut loose very little power is required to invert it. Now, in order to accomplish this with the least force, the point and wing of the share must rest as flat on the ground as is practicable. In this position the plow enters much easier than if the furrow slice must begin to rise as soon as the share commences entering the soil. On this single portion of the plow, inventors have manifested a great want of understanding of correct mechanical principles. Most of the plows of our country are defective in this

respect. The wing of the share stands so steep that the furrow slice must begin to rise before the share has entered a single inch. Any schoolboy can perceive at a glance that this is a great imperfection in the most desirable form of a plow. The furrow slice ought to be separated at least two inches before it rises much. If a plow were of such a form we should often be surprised to see what a small force would cut a furrow six inches deep in a heavy soil.

MEAD'S CONICAL PLOW.

451. The accompanying illustration of a plow represents a recent improvement made in the form of the common plow, which approximates the nearest to the correct form of a plow of any plow within my knowledge. It will be seen by the figure that

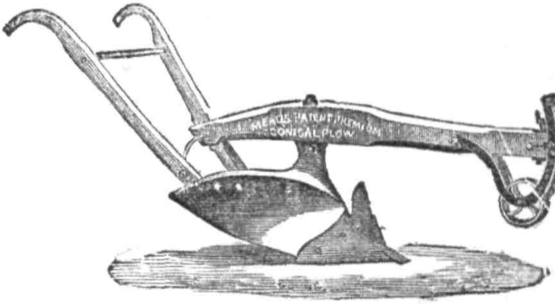


MEAD'S CONICAL PLOW—APPLICATION OF THE CONE.

the mould board is made to fit the frustrum of a cone, as shown by the dotted lines, with the large end of the cone forward. A log of wood turned round, of the form shown by the dotted lines, will fit closely to the surface of the mould board, from the highest point to within about two inches of the cutting edge of the wing of the share. The lower dotted line represents the

point where the furrow slice begins to rise. The first two inches above the lower dotted line rises but little. Therefore several inches of the furrow slice are separated completely before it rises much.

452. Another *perfect* point in the correct form of this plow is, the surface is neither concave nor convex. Consequently, the friction between the mould board and furrow slice is uniform. It



MEAD'S CONICAL PLOW COMPLETE.

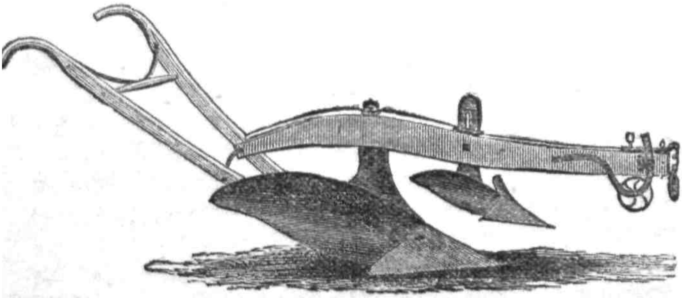
is no greater in one place than in another. When a mould board is concave, as a large proportion of them are made, when plowing light soils the moist earth is very liable to adhere in the lowest place, and prevent the slice from slipping well. When the mould board is made convex, the greatest pressure of the slice comes on the most prominent portion, while light earth is liable to stick to certain parts of the mould board.

453. The inventor, Mr. Solomon Mead, who is a practical plowman, describes his improvement thus: "The Conical Plow receives its name from the *mathematical principles* on which it is constructed—the concave or turning surface of the mould board being made to fit the surface of a cone, as represented above—the dotted lines showing the outline of the cone. The *broad* end of the cone being to the *front*, gives an *easy separation* and very gradual elevation to the furrow slice at the first—which is usually the hardest part of plowing—while the decreased size of

the cone, and the consequent increased curvature of the mould board to the rear, serves to act continually on the turning furrow, increasing the rapidity of turning as the power required to accomplish it diminishes. An examination of the *principles* of this plow must convince all, that in this *conical mould board* the adjustment and distribution of power for overcoming the friction of raising and turning a furrow is completely balanced. The points of merit sought and secured by this plan of construction are—*superiority of work in completeness of turning, thorough pulverization of the soil, leaving the surface even and mellow, and ease of draft for the work done.*" There are several sizes of this conical plow, and it appears to be admirably adapted to the wants of farmers who like a short, easy-holding, and light-draft plow. As it is very short on the sole, it is better adapted to stony ground than plows with a long sole.

ALLEN'S CYLINDER PLOW.

454. This illustration represents a recent improvement in plows, brought out and manufactured by R. H. ALLEN, who describes it thus:



ALLEN'S PATENT CYLINDER PLOW.

"This plow derives its name from the form of the mould board, which is a segment of a perfect cylinder, with its ends cut in the style of ordinary mould boards. Its lines are thus always horizontal

to the surface of the land, and consequently it turns the furrow slice with the same uniformity as a wheel on its axle, and with the least possible friction. The friction is still further reduced by the peculiar arrangement of the *point* or *share*, and *landside*, which, combined with its other improvements, reduces the draught from one-fourth to one-third less than that required by the best class of plows now in general use. For lightness of draught, simplicity of construction, ease of holding, and certainty of turning all soils of any required depth and width, it far surpasses any other plow. The capacities of the several sizes of the Cylinder Plow are as follows: The No. 0 is a one-horse or very light two-horse plow, and will turn a furrow from 10 to 12 inches wide, and from 4 to 7 inches deep. No. 1 has one plain and one cutter share, both of which will cut a furrow 12 to 14 inches wide, by 5 to 8 inches deep. This size is designed for rougher land and deeper tillage than the No. 0, and is a strong two-horse plow. No. 2 is larger, and similar to No. 1, but is easily drawn by two horses; will cut a furrow 14 to 16 inches wide, and 6 to 9 inches deep. No. 3 has the mould board of No. 2, with a deep tiller landside, and a wide cutting share. It is a heavier plow, and more strongly wooded than No. 2, and can easily turn a furrow slice 16 to 18 inches wide, by 8 to 11 inches deep. All the above plows are capable of turning either flat or lap furrows, of any required lap, by using shares suited to various widths, all of which can be supplied; and every furrow may be left concave on the under and convex on the upper side, which gives the lightest and most friable condition to the soil, admitting of easy and thorough pulverization by a light harrow or cultivator. The addition of a SKIM OR FRONT PLOW, attached to the beam in front of the main plow, secures the deposit of all the sod or turf under the upturned soil, which, besides effectually covering all the grass, leaves the ground sufficiently light for sowing even without the use of the harrow. This may be attached to either of the foregoing plows."

tions do, and must secure, to early plowed ground, a larger effective result in the proportion that it is longer subject to their action, in preference to and comparison with soil that is plowed in the latter and colder part of the season. In short, supposing late fall weather were even equally effective—though it is not—*in decomposing the surface mould*—ready for food for the next crop—it is clearly impossible for this to be done in as large a measure in only *one* month as in two. For the natural elements do not work spasmodically, but with steady regularity. Nature not only does not do two days' work in a day, but she always does her work in a season. She does not mistake heat for cold, nor her September work for that of November. As in the case of the manure heap, she decomposes the surface soil most rapidly and effectively when heat, air, and moisture are present in such measure and proportion as to effectually promote that result; and wise are her ways.

460. It frequently happens that some part of the autumn is dry; at whatever time the soil is too dry it decombines very slowly. If it be moist enough late in the fall for heat to rend the small clods and particles, by combining with and expanding their contained moisture, then there is *too little* heat to do this effectively. But if there be sufficient heat late in the autumn, there is *not* sufficient time for heat and water to do their work of expanding and separating. They cannot do a whole fall's work in a month. But in all our later autumnal weather there is always insufficient heat for the purpose of decomposition, as compared with the warmer weather of early autumn.

461. But if arable ground be plowed in September or earlier, it not only has sufficient time—rather than only half enough—but is put in a state for the most effectual combinations of heat, air, and moisture, to work out their joint functions in reducing it to a state of powder "smaller than any microscope can discern." Wherefore the chances are at least three to one in favor of an *early* plowed soil having its surface mould made fit to feed any crop that may be planted in it the ensuing spring, as compared with the more precarious chances of late plowed soils.

462. Furthermore, the closer, finer and heavier soils are in their composition, the more time and power, whether natural or mechanical, must be consumed in reducing them to a state of very minute fineness or impalpable powder, fit to feed plants with what they need. And clay and clay loams being more difficult of reduction to the minute state of impalpable particles fit for the ready absorption of plants than any more friable or lighter soils, it follows that clays and heavy soils generally need more time and natural and mechanical power to effect their reduction than such as are lighter and more easily cultivated. *Early* fall plowing affords not only more time, but more effective and certain results. Hence, while all but the lightest are much benefitted by it, clayey, compact, adhesive soils are naturally and beyond doubt more improved in the conditions most important to growing crops than those of any other description."

CRUSHING CLODS.

463. If a farmer could plow all his land at just the right time to crumble down to best advantage, there would be no use for clod crushers. Where there are several acres to plow, and the weather continues dry from day to day, much of it will become so dry that it will often turn up in large clods, in spite of all that can be done. When this is the case, it becomes necessary to make use of the roller and harrow alternately, until the hard lumps are reduced so fine that the rain will disintegrate them. If manure be hauled out in the spring, when the ground is wet, wherever the team poaches the wet soil—if it is a heavy loam, on calcareous clay—there will be more or less clods; as soon as the soil is plowed, and where the team passes several times in one place, there will often be so much lumpy earth, that it will hardly be practicable to get mellow dirt enough to cover a hill of corn. But the fault is not in the farmer. His teams and vehicles must travel over the soil, whether it is wet or dry. And even when the soil is thoroughly underdrained, and in a high state of fertility, it will plow up in lumps. It is sometimes utterly impracticable to plow a large field at the best time. Therefore,

since clods and lumps are unavoidable, we must adopt the most effectual and economical way to pulverize them. When they are hard and dry, they are hard to crush with any implement. But soon after a heavy shower of rain, when the soil has dried sufficiently to prevent adhering to the roller or crusher, they may be reduced to powder very effectually. Let a harrow follow the roller to bring up those that are partially burned, and roll the second time. If the roller be applied at the correct time, clods will give but little trouble. Where there are clods between rows of corn or potatoes, the best way to dispose of them is to turn out all hands with axes, clubs or mauls, and crush them. A blow applied with the flat side of an ax will do the business as effectually as anything. When weeds and grass are small, we have found this practice almost equal to a dressing with hand hoes. When a field is not underdrained, and is excessively wet, and heavy animals have been allowed to travel over it, we cannot expect much else but hard lumps when it is plowed.

464. I herewith copy what a correspondent of the *Country Gentleman* thinks about clods, simply to show that a man who has never worked on a clayey soil, thinks that if he sees a farmer managing differently on heavy soils from the usual custom with light soils, he don't know how to cultivate a soil properly. I would like to have the writer of the following suggestions manage a clayey farm a few years, and be obliged to haul out his manure, or not do it at all, when the ground is too wet to plow. Then I would like to have him read this specimen of ranting braggadocioism; and then see if he could tell how to avoid that "mistake" he alludes to, by having "lumps to crush." He writes: "This is a bad business—bad because it is necessitated. Any man who has lumps to crush has made a mistake. There may be slight exceptions to this in severe drought; but on the whole, lumps have no business on a farm. A rich soil, properly and *timely* tilled, will never be lumpy. We, therefore, always look with suspicion upon the man who cultivates lumps. 'But, you may crush them.' Ay! crush them? You can never crush them. You can reduce the

large clods to smaller ones; but they are still clods, little brick-bats, and are worth about as much as sand to your crop—hardly as much, as sand will warm your soil (where that is necessary)—whereas lumps are so much absolutely dead matter on your land—so much foreign or intruding matter which small stones and sand are not. Plow wet, ordinary or poor soil, and you are pretty sure of 'hubs.' The harrow will rattle them nicely along for you—and it will do this not only one year, but several at the least—and if the wet plowing is continued, your soil will be pretty well spoiled. Only deep plowing, the action of manure, and the effect of frost—all in the absence of further wet plowing—will restore your soil—and then it will take years. It is one of the most painful things in farming to see a man crushing clods. We will have no clod-crusher on our farm. Rather let your land lie unturned than work wet, or when hard and cracked after a long drought—which, however, is preferable to wet plowing. We do not half enough consider this matter. Not only plowing, but harrowing and cultivating are open to the same objection—but not to the same extent as plowing. Some soils are more readily drained than others. These are also less influenced by wet cultivation. Clay is the objectionable soil. A lumpy soil will not produce, and is a loss to a man greater than he imagines."

ROLLING LIGHT SOILS.

465. As many farmers discard the use of a roller for any kind of soil; and as I have alluded to the manner of using it on heavy soils, I here quote from the *Country Gentleman* a few thoughts on the management of the light soils in connection with a roller. To countervail the injurious effects of drouth on the light soils, there is practically nothing so effectual as the inversion of a close compact sod. The plow to be used for this purpose should be one which completely inverts and shuts in the furrow slice. The plowing should be followed by a heavy roller; there is little danger of getting the sod too compact, for it keeps the rising moisture below it from escaping— the decaying vegetable matter

of the sod, sponge-like, retaining the moisture. The roots of the grain, grasses, or other crops upon the inverted soil, will penetrate the moist sod and keep the plants fresh and green, while the same plants on similar soils destitute of the inverted sod, will suffer severely for lack of moisture. To obtain a close sod, red top and June grasses are the best. Some years ago we read in the New-England *Farmer*, some account of the great success attending the cultivation of large tracts of poor worn-out pine lands in Northampton, by Col. W. CLARKE, Jr. About that time we wrote to him upon the subject; in return, he kindly furnished the desired information. His course of culture was—"In the latter part of August and early part of September, with a good plow to completely invert the sod, if there was any, then press down the furrows with a heavy roller; harrow the ground and sow with timothy and red-top seed, and then again used the roller." He remarked, "without the use of a *heavy roller* in the culture of these light soils, I consider them of little value; but with its use, I think them the most profitable lands we have, except some of the alluvial soils, that annually or oftener receive by freshets rich deposits of sedimentary matters."

HOW LONG TO MAKE PLOW BEAMS.

466. While there is a difference among some manufacturers of plows for determining the correct length of a beam, many plow-makers have no regular rule for determining the length, and every beam is made "by guess." If a beam looks too long, it is cut off. There is a correct length for every plow beam, and if that length be increased or diminished, the draft or "balance" of the plow will be incorrect. We have ever maintained, that if a plow is constructed on correct philosophical and mathematical principles, with the beam of the right length, and the draught properly adjusted at the clevis, it will run alone and plow well, unless a stone or some obstruction throws it out. We have made inquiry of manufacturers for more than twenty years, concerning the correct length for plow beams, and found it all guess work in every instance but the following. SOLOMON MEAD,

a practical plowman, communicates to us a rule which he has adopted in determining the length of beams for his conical mould-board plows. In order to put this principle to a correct test, we visited his farm, and had his No. 6 adjusted to run about 5 or 6 inches deep, and to cut 10 or 11 inches in width. The draught ring was fixed at the middle of the end of the beam. Having adjusted it as nearly right as practicable we let it run alone, and plowed around the land some six or eight times in succession, without touching either of the handles, except at the ends of the land, in turning out and setting in. As the rule is not covered by a patent, any one can adopt it. This is the rule: Hold one end of a ten-foot pole, with no sag in it, on the share or mould-board at the supposed centre of resistance, a point 2 inches higher than the sole or bottom of the plow, and elevate the other end 4 feet and 2 inches, about the height of a horse's shoulders. If the beam is of correct length, a produced horizontal line (say the edge of a 2-foot rule) crowning the end of the beam will touch the edge of the pole held as above. If the length of the beam is increased, the forward end must be elevated, in order to be in the correct line of draught. When a plow is properly balanced, it will run as straight as the team travels, without holding. But when it turns quickly aside, either to the right or left, and the plowman is required to hold it constantly in position, it is a certain evidence that there is an imperfection in the mechanical construction of some part of the plow, or it is incorrectly adjusted as to the clevis, guage wheel, length of traces, or draught chain.

HARROWING SOILS.

467. Farmers do not half harrow their ground. The harrow is dragged over it; but the work of harrowing is not half performed, except in a few instances. The work is not done thoroughly. The harrow is designed to effect a more complete pulverization of the soil than can be done with the plow. The harrow is in one sense a system of small plows, cutting narrow slices, and thrusting them a short distance sidewise, without lifting the soil and turning it over. As a general rule, harrowing

is not done at the best time to pulverize the soil most thoroughly, especially where the soil is rather heavy. It is quite as essential to harrow a soil when it is between the wet and dry condition, as *it is to plow it when it is just dry enough to crumble well.* I was always accustomed to be more particular about harrowing at the right time, than plowing at the best period to pulverize well. Whenever a field was being plowed, whether in the spring, summer or fall, the best time for harrowing was closely observed; and, as soon as the soil had dried sufficiently not to be sticky on the surface, the harrow was put in motion; and all the plowed ground harrowed as soon as practicable. This time would oftener occur when a field was only about half plowed. But the plowing would be discontinued; and the team hitched to the harrow; and the seed harrowed in as far as the plowing was finished, for the sake of having the harrowing performed at a time when the soil would work lively and fall to pieces at a slight touch of the harrow teeth. Let me reiterate the thought, that it is quite as important—as far as thorough pulverization is concerned—to speed the harrow when the soil is just dry enough to pulverize well, as it is to plow when it is neither too wet nor too dry.

468. David Thomas, in an address in the Transactions of the New York State Agricultural Society, 1842, said: "I am satisfied that we have been too saving of our harrows. Thirty years ago there was a method of plowing called 'cut and cover.' It was plowing not on shares, but to the halves—the furrow slice covering a space where the furrow ought to have been. I am apprehensive that our ideas of harrowing were learned in the same school. After grain is sowed, is it not the prevailing opinion that it is harrowed enough, when it is covered? I had a narrow land harrowed sixteen times in one day; and was satisfied that the labor was well applied." Read the short Chapter on Harrows and Harrowing, Vol. I., and then resolve to harrow your ground more thoroughly in future.

PAYING FARMING AND PLOWING.

469. The reader may inquire what connection plowing has

with paying farming"—the prominent theme of this book. I answer, good plowing lies at the very foundation of good farming. If the soil is not well plowed or pulverized with some implement equivalent to plowing, no farmer can expect to raise remunerating crops. If a farmer performs his plowing in a cut-and-cover, slip-shod manner, there is little prospect that he will ever be able to distinguish himself as a first-rate farmer. Good plowing must precede good crops If a man expects to raise abundant crops, when he plows *decidedly bad, his expectations will eventually* disappoint him. If a man is a good plowman, there is some encouragement for hoping that he will make farming pay. But let me see a sleek, band-box farmer, who thinks much of nice fences, buildings and beautiful surroundings, and is not particular about his plowing, and I will point to a man who will eventually complain that farming don't pay. Americans are proverbially poor plowmen. If we see a nice piece of plowing done at our plowing matches, we find that it was done almost always by an Englishman or a Scotchman. We must plow better in America, or we can never expect to bring our agriculture to a paying and progressive condition.

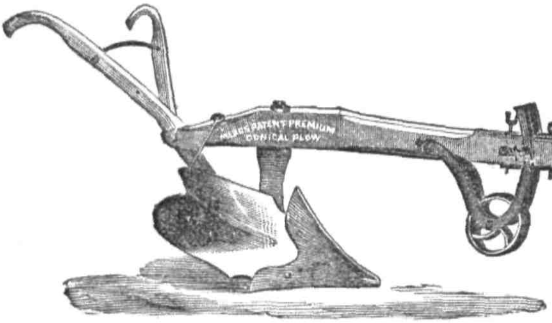
SIDE-HILL PLOWS AND PLOWING.

470. There are many different kinds of side-hill plows in existence, some of which are long, heavy, and disagreeable to handle, while others will not work well, except where there is a good slope. Some kinds are furnished with an iron flap at the upper edge of the mould-board, which prevents the loose earth from falling over the mould-board into the bosom of the plow. Side-hill plows are sometimes used for plowing level ground, by going directly back and forth across the field. But we cannot expect that a side-hill plow will turn the furrow slices as well as a plow having a single mould-board and a good land-side, although *it may pulverize* the soil quite as well.

471. Where land is plowed with a side-hill plow, or with any other plow, by turning the furrow slices down hill, in a few years a ridge of good soil will be formed at the foot of the hill ; while

at the top the surface soil will be turned from a wide space, leaving the subsoil quite bare. The soil over the entire field is moved downward about one foot every time a field is plowed. As it is constantly working down hill, in order to keep the ground smooth, an amount of soil equal to one furrow slice, should be hauled, every time a field is plowed, from the lower to the upper side. This will prevent the formation of a ridge at the foot, and a hollow or bare place at the top of a hill.

472. The accompanying illustration represents a side-hill plow, made on the conical principle (see par. 451), just invented



MEAD'S NEW CONICAL SIDE-HILL PLOW.

by Solomon Mead. From the appearance of the model, this side-hill plow will have no successful rival. I do not hesitate to recommend it to those farmers who are required to plow hilly land.

CHAPTER IV.

MANURES AND FERTILIZERS.

"The stable yields a stercoraceous heap,
Impregnated with quick fermenting salts,
And potent to resist the freezing blast." COWPER.

473. With the exception of thorough drainage, the great want—the thing most needed in American agriculture—is manure or fertilizers of some kind. As a general rule, our cultivation is better than fertilization; and much of the cultivation of the soil is done in a most superior manner. And although superior cultivation of the soil is, in part, a good substitute for manure, still some kinds of fertilizers are absolutely essential in order to produce remunerating crops and to keep the soil in a good state of fertility. And although the soil in many of our States seems to possess almost inexhaustible fertility, still the time will come when those fertile soils will fail to yield abundant crops, unless some kinds of fertilizers are applied to restore those elements of fertility which have been removed in the crops.

474. But it is to barnyard manure, to clover, maize, and other home-made fertilizers, that American farmers are to look for material with which to keep their farms in a good state of fertility, as well as for restoring those soils to a good state of productiveness, that are naturally barren, or that have been impoverished by a long succession of exhausting crops, without

there having been anything returned to them to compensate for those elements of fertility that have produced the crops.

475. Manure is the great motive power in American agriculture, as well as in oriental countries. Without it, a farmer may have the best tools and implements that can be found; may drain his soils most thoroughly; and may cultivate them in a most superior manner; but if he neglects to save and to apply the manure that may be made from the resources of his farm, sooner or later his soil will inevitably become impoverished.

476. Therefore as manure is the great source of productiveness on the majority of soils; and as American farmers must depend, for the most part, not on foreign fertilizers, but on barnyard manure, to maintain the fertility of their farms, my aim will be, in this chapter, to lay down such rules and instructions for saving and applying barnyard manure, and other fertilizers, as will enable the young farmer to perform this part of agriculture in the most economical, successful and farmer-like manner.

477. I will, by no means, decry foreign fertilizers, nor pen anything to discourage their application to the soil. Indeed, I approve highly of their use; and shall give reliable directions for applying them. But the chief idea will be to advocate the economical saving and use of the manurial resources of the farm *first;* and then, if guano, poudrette, superphosphate, or bonedust is needed, let it be procured.

478. I do not approve of purchasing any kind of fertilizers as long as a good proportion of the manure of the stables, the piggery, the hennery, and the privy is allowed to go to waste, either by leaching or by evaporation. And if a farmer is careful to collect all the fertilizing materials that his farm will afford, and to apply them to the soil in the most proper manner, the application of foreign manure will not be so necessary as it might otherwise appear to be.

VALUE OF BARNYARD MANURE.

479. Mr. JOHN JOHNSTON penned the following thoughts for the *Country Gentleman* on this subject, which coincide well

with my own views :—"Every farmer knows, or ought to know, that barn-yard manure furnishes all the elements of nutrition that are needful for any grass or grain that is grown in the northern latitudes, and, I presume, in southern also. It is true, if you manure highly with barn-yard manure for a number of successive years, that the straw will grow soft and weak, and the grain shrink ; but this may be remedied by the application of lime, at the rate of 40 to 80 or 100 bushels per acre. This will give a more elastic straw, and a brighter and plumper seed. But to apply only three to six bushels per acre, as recommended by some chemists, would be like giving a horse or an ox a gill of corn for a feed—its effect could not be perceived. The application of a barrel of salt per acre, to lands thus highly manured for years, will produce a similar effect, rendering the grain plump, and the straw bright and elastic."

480. These observations are correct, with some qualifications. If barn-yard manure were all made of the same materials as Mr. Johnston is accustomed to use, which are hay, straw, cornstalks, cereal grain, or meal of that grain, and oil meal in abundance, these thoughts would be correct. But when barn-yard manure has been made of straw, cornstalks and a little hay, and a very small amount of grain, or none at all, it may be valuable manure, to *appearance*, but in reality it will be destitute of that amount of grain-forming substances which renders Mr. Johnston's manure so valuable.

481. Manure that has been made of such materials will produce a luxuriant growth of straw or of grass, but the kernels of grain will be small. If one manures with straw, the crop of straw will be increased ; but in order to increase the quantity of grain, there must, of necessity, be material in the manure that will form grain. Therefore the value of barn-yard manure for increasing a crop of grain will depend, in a great degree, upon the amount of grain that has been consumed by the animals that made it.

SAVING MANURE.

> "All manner of straw, that is scattered in yard,
> *Good husbandly husbands have daily regard;*
> In pit, full of water, the same to bestow,
> Where, lying to rot, thereof profit may grow."—TUSSER.

482. Every thing that will make manure should be saved. It is poor policy, indeed, to have grain thrashed in the field, as thousands of farmers practice doing, and allow the straw to remain in a large pile to rot down, and waste away, and never distribute it over the field. It is equally bad policy to consume in feeding, and use up for litter, in the barn-yard and stables, all the products of the farm, and allow them to lie exposed to the influences of the weather—rain and sunshine, sometimes from year to year; and the practice of having drains, nearly full of small stone, made in the middle of a barn-yard, or of having it so elevated that all liquid will be carried away—as thousands of farmers do—is a practice to be strenuously avoided, if manure of the first quality is desired. In making barn-yard manure, it is better to have the manure just moist enough to make it rot well, and to prevent it from heating and becoming "fire-fanged."

LIQUID MANURE.

483. One of the most important considerations for the farmer to understand well, is the action of liquid manure in promoting the growth of plants. Let us ask *how* manure promotes the growth of plants of any kind? and who can give a correct answer? Not one in ten, even among those who profess to know that fertilizers are very essential for the growth of grain, grass or weeds.

484. Every atom of manure must become dissolved—must pass from a solid to a liquid state—before it can promote the growth of any plant, except the *mechanical influences* which it exerts, while it is in a solid condition. Barn-yard manure must have water applied to it, to dissolve and wash out the little atoms of fertility, before the roots of plants can absorb them. Roots cannot take up *solid* matter. Every thing must be in a

state of liquidity. If guano, poudrette, or hen's dung be applied to the soil, rain must first dissolve those substances and carry them downward in the soil before they can be of any value as fertilizers. Bones must first be dissolved, and the little atoms must be carried into the soil, where the roots will absorb them and carry them up into the leaves. Gypsum will exert no perceptible influence on any plant until it is broken up, ground fine and then dissolved, before plants can be benefitted by it as a fertilizer. And so with the particles of soil, before they can promote the growth of any plant, they must be dissolved in atoms, inconceivably small, and they must be in a liquid state.

485. We have seen, in Par. 224, how soils are formed by the disintegration of rocks. The rains and frosts are constantly in operation, preparing food for plants. The process is very slow, it is true; but every shower of rain dissolves a little more, and a little more. And if the soil be stirred up and worked over often, this will greatly facilitate the dissolution of solid portions of it.

486. The intense heat of summer, and the rains, operate very powerfully in dissolving the solid particles of fertilizing matter in the soil; and this is especially true where no crop is raised on a soil, as in summer fallowing. And on this principle we are to account for the fact, that a summer fallow will always produce a superior crop of wheat; because, stirring the soil in hot weather, and the alternate showers and scorching sunshine prepare a great amount of nourishment, which the roots immediately take up; and which promotes the growth and complete development of the crops that are raised on those soils.

FERMENTATION OF LIQUID MANURE ESSENTIAL.

487. From the foregoing considerations, one might suppose that if liquid manure—the urine of domestic animals, or of the human species—were applied to plants, it would promote a very luxuriant growth. But this is not so. Liquid manure, when applied to plants in a recent or rare state, will often exert a very injurious influence on their growth, as may be observed by

liquid manure from escaping into the air. But even when thus diluted, it is desirable to convey it to the soil without much loss of time, since even in this state there will be a constantly slow escape of ammonia, by which its value will be daily diminished.

497. In Flanders, where liquid manure is valued highly, the urine of a single cow is valued at from six to eight dollars annually, and is frequently contracted for at that price. Let every farmer, with the help of the facts above stated, make a fair calculation of what is lost to himself and to the country by the hitherto unheeded waste of his cattle; and he will be able clearly to appreciate the importance of taking some steps for preserving it in future.—*See Johnston's Agricultural Chemistry.*

LIQUID MANURE AMONG EASTERN NATIONS.

498. When we read about the practices of oriental nations, we cannot repress the conviction, that the agriculture of our country, so far as saving and applying manure is concerned, is very far behind other countries. Indeed, as a nation, our practices with manure are very slack and slovenly. Nearly the whole cultivation of China, where there is about 360,000,000 of inhabitants, is done by the application of sewage manure, which is applied in a liquid state. Whatever may be the latitude—and there is an immense range—whether the weather be cold or hot, the manure is always applied to plants in a liquid state.

499. The Chinese say, that you do not require to manure or fatten the soil; but, you want to feed the plant. Therefore they do not manure the soil previous to sowing seed; but they manure the growing plant. By the liberal application of fertilizing material to growing plants, while in a liquid state, the inexhaustible fertility of China is maintained at its present pitch. The Chinese save what we Americans waste; and thus keep their agriculture in a progressive state.

500. The custom of the Chinese is to collect all the urinary and excrementitious matter from their dwellings, daily, for manurial purposes. And the way in which they apply this sewage to the soil is, they take a small quantity, and put it into a bucket

of water, and dissolve the solid portions of it by soaking and stirring it. Then, this diluted liquid is sprinkled around the roots of plants. The most proper time for this purpose is just as the sun is setting, or previous to a shower.—(*See Transactions of the N. Y. State Ag. Society*, 1862.)

501. In some localities in the Old World, we have seen it stated that all the solid manure is leached at the barn yard, and then carried in pipes, underground, all over the farm; and a hand hose can be attached to the pipes, at convenient points, so that the entire field can be sprinkled copiously with liquid manure. These facts are simply adverted to for the purpose of impressing the young farmer with the importance of saving and applying all the liquid, as well as the solid, fertilizers of the farm.

SALT AS A MANURE.

502. There are many good farmers of our country who have long advocated the use of salt as a most excellent manure. But we have never been able to obtain any reliable information on this subject that would warrant its use. Those who have advocated its use, say: "we *think*, we *believe*, and we *know* that salt is a good manure." Still, they have never satisfied themselves that it is so by any well-conducted experiments. Salt has been recommended to be sown with winter wheat in autumn. But those who have used it can give nothing tangible by which the young farmer could determine whether the salt was the means of increasing or of diminishing the crop.

503. It has been asserted, that when a few hundred pounds of salt are sown on an acre of wheat, it would make the straw stiffer and brighter; and consequently the crop of grain would be better than if no salt had been sown on it. But when we come to call for positive knowledge on this point, we find nothing but shrewd guessing as to the effects of the salt. Therefore, until we can have some reliable facts on this point, our advice would be to young farmers, not to spend much money for salt to apply as a manure.

504. This subject has elicited a vast amount of thought and investigation in Europe. A commission, on the part of the French Government, have recently reported, that "salt, as a manure, was of no value." Mr. Lawes, in a paper read before the Royal Agricultural Society, detailed some very interesting experiments with salt, which showed that salt was of no value at all on his land, "either in increasing the amount of straw or grain." And he did not hesitate to assert, "that the large amount of money which is expended annually on salt, as a manure, throughout the British Isles, is not returned in the produce."

505. There are certain kinds of soils, there is no doubt, where an application of three or four bushels of salt per acre will benefit a crop of grain or grass more than enough to pay for the salt and the labor expended in sowing it. Some farmers have fancied that it has been very effectual in killing grubs, when applied at the rate of three or four bushels per acre. Mr. John Johnston, one of the greatest wheat growers in the country, insists that salt is an excellent dressing for winter wheat. Many others have failed to see any good results from it, or from its application.

ABOUT STERCORARIES.

506. There has been not a little written and published concerning manure vaults, and liquid manure cisterns, and cellars for manure, all of which have conveyed a very plausible notion about saving manure; and I know of some farmers who have been to great expense in fitting up spacious cisterns—some, forty feet long, and twenty feet or so in width, with the walls inside covered with a heavy coat of cement, for the purpose of holding stable manure.

507. But in a country where manual labor is so very expensive as it is with us, we cannot afford to pay a man for fussing, leisurely, with barnyard manure. And, moreover, when manure is deposited in such spacious vaults, it will require much hard

labor to get it out of such places on to a wagon. It is infinitely easier to write out directions about forking over a pile of barnyard manure, where there is from one to two hundred loads, than it is to do it, or to get it done ; and it is a very easy task to tell all about saving the liquid manure in large tanks ; and it requires but little muscle to talk or write about having all the manure from the horse stables and the cattle stalls tumbled into a huge cellar, with a layer of muck and a sprinkling of gypsum. It is very pleasing to think that none of the valuable fertilizers will be washed away from the manure when it is thus disposed of.

508. But here is a consideration that most writers have overlooked, which is, the hard labor required to load the manure from such places and get it into the soil without wasting but little of it. Talk about forking over a hundred loads of compost or barnyard manure, where it is two or three feet in depth ! We can talk and write about it ; but who will do it ? It will be a heavy and laborious task ; and with the present prices for labor, we must devise the easiest possible method of handling and managing barnyard manure or we shall increase the cost of the manure more than the profit which will be derived from it. With these ideas about stercoraries, let us pen a few thoughts concerning

THE WAY TO MAKE A BARN-YARD.

509. The most important consideration concerning a barnyard where manure is to be made, is to have the buildings standing on a slope of land. If it were practicable, there should be hill enough to admit of the stables being constructed in the basement, with a sub-base beneath the stables for the manure. This sub-base should be on a level with the yard, in order to facilitate loading the manure when it is to be hauled to the field. By having trap-doors in the stable floor through which the manure can be thrown down and spread around under the stalls, all the liquid will find its way among the solid manure and be absorbed , and will not be lost by leaching nor evaporation.

510. We know of no better way of arranging stables and a manure yard than this. If muck, or peat, or humus be used

among the manure, so much the better; as it can be thrown down into the stable; and then, with a little labor, it can be thrown down into the sub-base of the barn. A row of sheds ought also to be erected on three sides of the yard, for the purpose of collecting and carrying off the rain. And the ground ought to be excavated a foot or two in the centre, for the purpose of collecting the wash of the yard. Of course, every roof should have a good eave-trough; and the water which is collected in them ought to be conducted into a spacious cistern, or into a good underdrain, which ought to be made entirely around the yard, of sufficient depth to keep the ground dry.

511. If a farmer will construct his barn-yard according to this plan, he will be sure to save all his manure—both liquid and solid; and at the same time his manure will be very accessible at any season of the year. If it were desirable to let it remain in the yard until autumn, it could be kept there without any appreciable loss. And although it were under sheds, so that no rain could fall on it, there would be little or no danger that it would fire-fang, if the liquid manure of the animals were deposited with the solid portions.

ANOTHER WAY TO MAKE A BARN-YARD.

512. Many times a barn, or stables, must be built on level ground, as there is no natural hill to make a convenient place for building with stables in the basement. Under such circumstances, there could be a basement built for the stables, with the floor laid close to the ground; and the yard and sheds around it should be constructed as recommended in paragraph 509.

513. Perhaps it will be interesting and instructive to the young farmer to read a description of the yard and stables which the writer once constructed, and which gave good satisfaction. The ground was nearly level. From the front side of the barn to the farther side of the manure yard, perhaps there was a descent of two feet. The stables were in the basement of the barn. The floor was laid close to the ground, which was a very compact gravelly clay subsoil. Before the floor was laid, the

ground was graded, so that all the liquid would descend to a large hole, where there was a manure pump at one side of the stable, for the purpose of pumping up the liquid manure. This earth was about on a level with the manure yard, which had sheds on three sides of it. The manure was taken from the stalls on a wheelbarrow, and spread, every day, under these sheds—the cattle manure and the horse manure being mingled together.

514. The roofs were furnished with eaves-troughs, which conducted the water into tile-drains, which had been made entirely around the yard, two-and-a-half feet in depth. These kept the soil very dry ; and none of the soluble portions of the manure were washed away by heavy rains. The stalls were frequently washed with a pailful or two of water each, which carried all the valuable portions of manure to the hole, where the pump would bring it up, when it was conducted in light troughs to any part of the yard, where it would be absorbed by the solid manure. In this way, the most valuable portions of the manure were mingled with the solid portions ; and being kept damp beneath the sheds, it never became fire-fanged. Here it would remain all summer, without any loss. And it was very accessible at any time when it was desirable to haul a little or much of it to the field.

515. By having the hard earth graded smoothly, and by dashing water over the stable floor occasionally, all the liquid was saved ; and by pumping it up it was disposed of in the most economical manner.

MANAGEMENT OF MANURE.

516. There are not a few considerations of great importance in making, saving and applying manure to crops. But the great idea is—where the price of labor is so high as it is with us—to save all the soluble, as well as the insoluble, portions of the manure, and apply them to the soil, without losing any of it by evaporation, either in the yard or after it has been hauled to the field, or without allowing any of it to be washed away by heavy showers. This is the *chief* end to be kept in view. There are

other considerations, which are of no little importance, concerning the manner of performing the labor, which we shall dwell upon at some length, all of which will tend to the same great result—saving, making and applying barnyard manure in the most judicious and economical manner.

517. After the barn-yard has been constructed as directed, (paragraphs 509, 510) if there are cow stables and horse stables, care should be exercised to have the manure from each stable spread evenly over the entire surface, under the sheds, for the purpose of having all the manure of a uniform quality. Too many farmers allow the manure from the horse stables to be all thrown in one place ; the manure from the stables of neat cattle to remain in another part of the yard ; and in another part of the yard it will be nothing but decayed straw. This system of managing barn-yard manure is a very injudicious one—which the young farmer should guard against—because some portions of a field would be very heavily manured, while others would receive a very small amount of fertilizing matter. But if all kinds of manure are mingled together, the whole mass will be of a uniform quality.

MANAGEMENT OF SWINE MANURE.

518. The manure of fattening swine is, usually, very rich in fertilizing or grain-producing material. Therefore a little of it will manure a large surface, if it be managed economically. When swine are fed on unground grain, as they often are, they extract only a small proportion of the grain. The remainder goes off with the droppings—some in a liquid and some in a solid condition. The reason, therefore, why swine manure will produce more grain per acre than the manure of any other domestic animal is, almost their entire food is grain ; and consequently their ordure will be very rich in grain-producing material. No one can fail to perceive and appreciate this fact.

519. Now, the grand idea is, to distribute this rich manure evenly over a large surface of soil. If it be hauled to the field, as it usually is, direct from the piggery, it will not be spread

economically over the field. Therefore it would be a better way to haul it to the barn-yard, and mingle it evenly with the other manure, before hauling it to the field. By this means it will be evenly distributed over a large surface of ground, and will produce much more grain than if it were applied in its concentrated condition, as it usually is found at the piggery.

520. Swine manure ought always to be protected from the influence of rain and sunshine ; because it is so rich in ammonia that it will pay well to spend a little time in saving it. This may be done most economically by having the manure apartment outside of the pen covered with a few boards and well supplied with muck, mellow soil, sawdust, or some other absorbent. By this means the manure, both liquid and solid, will be deposited in one place ; and no labor will be required only to shovel the absorbents into the pen. And if enough be shoveled in every day to keep the apartment dry, a large amount of excellent manure may be made by a few swine. The droppings of swine are so offensive—so full of ammonia, which is the life of plants—and their habits are so neat, with respect to their voidings, that it is not difficult to keep all their manure, both solid and liquid, in a body by itself, if provision is made for that purpose.

COMPOSITION OF BARN-YARD MANURE.

521. There is more difference in the qualities of barn-yard manure than there is between a delicious bow apple and one that has been frozen and thawed, which no one would care to eat. And this is a subject which a large proportion of American farmers at the present day almost lose sight of ; and I am sorry to say that this point is very imperfectly understood.

522. The excellence of barn-yard manure for increasing the amount of grain of any kind depends, in a very great degree, on the kind of food that the animals subsisted on while the manure was being made, and on the proper management of it until it is applied to the soil. The proper management of barn-yard manure involves its protection from storms, from becoming fire-

fanged, and from evaporation. In discussing this subject, we shall treat it as if none of the soluble portions had been or would be allowed to go to waste.

523. Manure may abound in grass-producing or straw-producing material, but will not increase the crop of any kind of cereal grain. And why? Simply because there is very little material in it that will produce grain. If animals were fed on hay, straw, and cornstalks, without any grain, they may produce a large amount of good manure for increasing the next crop of grass, stalks, or straw. But the kernels will be small.

524. Now, when we feed a bullock twenty pounds of meal of Indian corn per day, besides ten or fifteen pounds of hay, he will extract and secrete only a small proportion of that meal in the form of fat and flesh. But, what becomes of it? Why, it passes off in the ordure, and in the urine, which are as full of grain-producing materials as manure can well be. Therefore the manure of a fattening bullock, when his food is oil meal and Indian corn meal, will produce more grain than the manure of half a score of bullocks that subsist entirely on coarse fodder, without grain or meal. And the fatter a bullock, sheep, horse, swine, or any other animal may be, the greater will be the amount of fertilizing material in the ordure and urine.

525. When swine are being fattened on Indian corn, ground or unground, their ordure is composed almost entirely of the very best grain-producing material. Only a limited portion of a bushel of grain will be secreted in forming fat. And this grain-producing material will be better fitted to promote the growth of grain, after having passed through the swine, than it would be were the pure meal of the grain used as a fertilizer. (See paragraph 467.)

526. This subject may be still further illustrated by alluding to the ordure of hens, and other domestic fowls. When a hen lays an egg every day, she will, and necessarily must, consume more food, for the purpose of extracting the albumen—which composes the egg—than will be consumed by several other hens that do not lay. Therefore a large quantity of grain, meat, or

other food must be consumed and digested, almost solely to extract the albumen which it contains. The remainder passes off in the ordure. And this fact accounts for the excellence of hen manure. The droppings of laying fowls are far richer in grain-producing material than the droppings of those fowls that do not lay.

527. From these considerations we are able to understand why guano (*See* Guano) is such an excellent fertilizer in increasing the amount of grain and vegetables when it is properly applied. The birds whose droppings form guano, subsist almost wholly on flesh; and as they usually consume large quantities of fish, but little of it is secreted by the birds in the form of fat and flesh.

COMPARATIVE VALUE OF THE MANURE OF FAT AND POOR, OR WELL-FED AND POORLY-FED TEAMS.

528. On this subject of the composition of barn-yard manure, the *North British Agriculturist* contains some very sound ideas, which we consider worthy of especial perusal, in order to gain a good idea of the estimate which other writers have placed on this kind of manure. The author says: "Farm-yard manure varies considerably in composition, the variations depending upon the animals kept; the manner they are housed; the amount and character of the food consumed by them; the kind or quantity of straw used as litter; the period of the year the manure is made; and whether it is made and kept under cover or exposed. The amount of water in half decomposed manure is seldom less than 80 per cent. Some chemists have estimated it as low as 75 per cent., but this is below the quantity of moisture present in ordinary farm-yard manure. The moisture is derived partly from the urine of the stock; and, under ordinary conditions, a part is due to the rain water absorbed.

529. "On many farms the manure is not only exposed to the direct rain-fall, but the water which collects on the roofs of the buildings is allowed to saturate it. The consequence generally is, that a considerable portion of the soluble elements are

washed out of the manure, which liquid stream is usually allowed to escape to the nearest ditch, from a belief that it contains little fertilizing matter. The urine of animals generally contains nearly as much fertilizing matter as the excrement; and any liquid from the dung heap contains a portion of the urine. Apart from the urine present in the liquid, there are also present, in a soluble state, a portion of the fertilizing elements which were in the excrements, and a portion which were in the straw used as litter. When it is considered that the liquid from byres, cattle courts, and manure heaps is generally nearly all lost, and that this liquid from the heap is not all rain water and melted snow, it should be evident that a considerable waste of the fertilizing elements in the farm-yard manure arises from the manner in which it is produced, collected, and kept previous to its being applied to the soil. Under ordinary circumstances, as to cultivation and climate, it is not requisite to form a tank to collect the liquid; but it is generally advisable to prevent the saturation of the manure in a court by placing troughs along the eaves of the roofs. With such a provision to carry off the rain water, any direct fall of rain seldom washes out any fertilizing elements, the water being absorbed, and part of it afterwards being removed by evaporation. During certain periods of the year the amount of moisture removed by evaporation is very considerable. It has been frequently observed, where cattle were kept in open courts with sheds attached, that in spring the quantity of straw required to keep them comfortable was less than that required for the same number of cattle fed in covered boxes.

WASTE AND FERMENTATION OF MANURE.

530. "Waste arises from several causes, the most common being a washing out of the soluble constituents from exposure, and the loss of the gaseous elements from fermentation, induced by placing the manure in heaps previous to applying it to the land. During the process of fermentation, a considerable portion of the constituents of farm-yard manure are driven off. When the manure is compressed by the treading of stock, fermentation

proceeds much more slowly than when the manure has been thrown loosely together. When the fermentation proceeds slowly, moisture is the principal constituent which escapes; but when fermentation is active, with considerable heat, a portion of the nitrogenous element escapes generally in the form of ammonia. Beyond hastening the action of manure, and destroying the vitality of the seeds of some weeds, there is nothing gained by fermenting manure in a heap. On the contrary, the organic fertilizing constituents are diminished in part, and the mechanical action of the manure necessarily impaired. It is advantageous to all soils, more particularly to argillaceous ones, to apply manures in a green state at certain seasons. The cultivator of the potato finds it advantageous to manure the land in autumn with farm-yard manure, preparatory to the growing of the crop. So also the cultivator of the Swedish turnip, and of the legumes. Experiments are much required to elucidate the action of fresh farm-yard manure in and on the soil during the winter. Some suppose that the constituents of plant life in the soil are rendered more accessible to plants by being made soluble by the presence of this manure in or spread on the surface of the soil, while others believe that by the presence of the slowly-decomposing manure, ammonia is attracted from the atmosphere and retained in the soil ready to be taken up by the crop. The researches of Professor Thomas Way showed that ordinary soils have the power of retaining the constituents of plant life, although these are in a soluble state, until the growing plants assimilate these constituents during their growth.

531. "Those who are familiar with the beneficial effects which arise from the spreading of farm-yard manure on the surface, and allowing it to be exposed to the atmosphere for some months, know that the fertilizing action of the manure is more marked in the succeeding crop than if it had been applied during winter or spring after being fermented. The action may be partly mechanical; but it is now ascertained by the researches of chemists, that during the period of exposure the nitrogenous elements are increased in amount, being generally in the form of

nitrates; the increase being regulated in part by the temperature of the atmosphere, the constituents of the manure, and perhaps also by the constituents of the soil."

TOP-DRESSING WITH UNFERMENTED MANURE.

532. By spreading fresh manure on pastures and meadows, and after exposure for some months, collecting by horse rakes the manure not decomposed, a striking difference in the character of the herbage is the result. Doubtless, this is mainly owing to the constituents of the manures which have been washed into the soil during the period the manure was exposed. Still, there is some mechanical action arising from a covering of manure, for upon inspection the soil is found to be more open, and the roots of the plants more vigorous. The same mechanical action can be observed in stubble lands, particularly where the soil is argillaceous. The soil is not only more friable, and therefore more porous, but the color is partly changed, showing that the action of the atmosphere has been increased by the manurial covering.

533. Those who entertain opinions strongly in favor of fermenting manure in dunghills, previous to its being applied to the land, should undertake experiments by manuring portions of fields intended for green crops during the next two months—the same quantities of manure applied to the portions of the fields being placed in heaps for spring application to the same extent of land manured in autumn. The results will probably surprise the cultivator who has hitherto only applied fermented manure to the soil. During the spring months it is generally found to be advantageous to apply manure in a state of advanced decomposition, particularly where it is being applied to land intended to be immediately sown with the seed of the turnip; but during summer, autumn, and winter, it will generally be found profitable to apply manure direct from the cattle courts and dunghill, without any previous turning to induce fermentation.

PROFIT OF SHELTERING MANURE.

534. The *American Agriculturist*, previous to my editorial con-

nection with it, contains a short article on this point, which I consider worthy of being read by every farmer, because they all need line upon line about sheltering manure: "It is now pretty well settled by the experiments of intelligent agriculturists, that manure protected from the weather is much better than that which has lain for six months or more in the open yard. Every farmer who has cleaned out his stable floor where there was no cellar, or has used the manure made on the floor of the sheep barn or shed, has had occasion to suspect as much. Crops fertilized with such protected manure started with great vigor, showing a dark green color, and pushed on rapidly to maturity. There must be something in such manure that the unsheltered article loses.

535. "An English experiment shows that manure which was kept covered by nine inches of earth, produced several bushels more of grain per acre than the same amount of manure applied to the same extent of land, which had lain exposed to the weather during the winter. Another experiment shows a difference of about four tons, or nearly one hundred bushels, between the produce of two acres of potatoes, the one of which had 20 loads of covered, and the other 20 loads of uncovered manure A gain of fifty bushels of potatoes to the acre, just from the difference in the quality of the manure, is worth looking after. It will be seen that this is nearly all clear profit. There is no more expense for seed, for handling manure, or for tillage. The only additional item would be the increased labor of harvesting. The conviction that the housing of manure is good economy is pretty general, and yet not a fourth part of our farmers pay any attention to it. The open yard, without a barn cellar, and even without sheds, is still a very common spectacle.

536. "The best substitute for lack of cellar is a covering of earth or muck for the manure as fast as it is collected. If the open yard were kept well supplied with muck, and the manure were to be plowed under every month, but without draining off, it would not waste much. Where straw is plenty, as in the wheat growing districts, it makes a very good covering for manure.

This is the practice of some of the best managers. But it requires a much larger quantity of straw than most of our farmers have for litter. The straw is thrown out frequently, and the yard is kept nearly dry for the cattle to lie on. Muck usually costs nothing, except for digging and hauling; and rightly managed it makes a good protection for manure. It should be scattered frequently over the yards and under the sheds, and the heaps kept well covered.

537. "A Canadian farmer complains that he has followed our advice, and his manure dried up, heated, and was nearly spoiled—in other words it "fire-fanged." This reminds us to repeat, that while no liquids should be allowed to run from the manure heap, it *should always be kept moist.* The heap should be frequently examined, and if found drying out, water should be added. The *best* plan is to pile the manure in a tight vault or excavation that will hold the liquids. If not under a roof, a cover of loose boards will answer, as a little rain falling through will do no harm. Then, as often as needed, pump up or dip up with a bucket the liquid from below and spread it over the heap. This liquid manure will hasten the decomposition of the straw and other coarse materials, and all the heap will be equally rich."

PROTECTING MANURE IN WINTER.

538. In view of the fact that there is such an abundance of grain-producing material in the manure of those animals that subsist on grain or meal, we perceive at once the great importance of keeping such manure where rain will not wash it from the straw and carry it off to the ocean. Protecting manure, by erecting cheap sheds over it, is an item of labor that farmers can work at in the winter very advantageously and profitably. And while they do this work, they are taking a very important step towards introducing a renovating system of farm management, and of improving the fertility of their soil, not only for grain, but for grass or vegetables. Where the water from the eaves of the buildings is permitted to fall on the manure yard, eave troughs should be put up as soon as may be practicable, as a few heavy

showers will often injure the value of manure enough to pay the expense of good eave troughs to a barn. The skilful farmer's motto must be, in the winter, to save all the manure, and raise large crops next season.

539. Farmers should remember that when they feed grain to animals that are being fattened, those animals appropriate but small proportions of the grain or meal which they consume, to the purpose of building up their frames and secreting fat. What, then, becomes of it? Why, it passes off in the manure. And this is the grand reason why the manure of fattening animals is so much more valuable for crops than the manure of store animals. In a bushel of Indian corn, for instance, there are fifty-eight pounds of grain, which will make, according to the circumstances and condition of animals, from three to twelve pounds of flesh and fat. Now what becomes of the remainder of the 58 pounds? A portion of it is consumed—burnt up as fire burns wood—in sustaining the necessary warmth of the animal. But the greater proportion is cast out in the droppings. This rule holds good in fattening neat cattle, sheep, swine, and all other domestic animals. And herein, to a great extent, lies the real profit of feeding animals on grain. The profit is in the *manure*. If that is lost or wasted, the profit is very small, or there is no profit at all.—*Country Gentleman.*

RED CLOVER AS A FERTILIZER.

540. Red clover (*Trifolium Pratense,*) on certain kinds of soil, is one of the most convenient, economical and effectual fertilizers that can be employed for improving the fertility of an impoverished soil. And its excellence and importance as a fertilizer is not half appreciated, except by a few of our best farmers. Most farmers who have succeeded in raising a good crop of clover, are quite too apt to think that they had better make hay of it, after all; or that it will be as well to pasture it off and raise a crop of seed as to plow it under. But the great difficulty always is, in such instances, every thing continues to

be carried off the soil; and nothing is left nor returned to it for the purpose of keeping up its fertility.

541. Red clover, and lime, and gypsum, in connection with all the barn yard manure a farmer can make conveniently, will constitute the most economical fertilizers, for most kinds of soils, that a farmer can use. Red clover, with a light sprinkling of gypsum, on some kinds of soil, and lime on others, will grow luxuriantly where many other kinds of grass would never flourish at all; and on many barren hills and slopes, where the soil has always been very poor and the herbage small, thin, and of a sickly appearance, red clover, with good cultivation, if plowed under as a fertilizer, will effect a change in the character and productiveness of the soil which could not be produced as cheaply and expeditiously by the use of any other fertilizer.

542. The excellence of red clover as a fertilizer consists in its peculiar character and habit. It throws long tap roots downward into the subsoil, which, of course, absorb fertilizing material which has long rested too far below the surface to aid vegetation; and it brings it up for the purpose of forming the stems and leaves. Of course these tap roots will render the soil more porous than it was before. Then, when the roots decay, they furnish a large amount of vegetable matter, which will be readily taken up by the roots of other plants growing where these large tap roots have decayed.

543. Red clover reminds us, in its operations on the soil, of the good effects of earth worms in working over and reducing it to a very fine condition. We have no other plant which will exert such an ameliorating effect on soil as red clover. The roots often extend far below the line where the plow has turned up the earth; and thus they operate in a measure like a subsoil plow, by loosening the subsoil without throwing it to the surface.

544. Then here is another important consideration concerning red clover as a fertilizer. Its large leaves absorb a large quantity of ammonia—which is the very life of all the cereals—from the atmosphere. By this means, a greater number of tons

of the best fertilizing material is obtained, which will greatly improve the fertility of the soil, providing it be plowed under at the proper time.

545. R. L. ALLEN, in the *Am. Farm Book*, says on this subject: "The roots of red clover exert a power on the soil beyond any other known agents, either of manure or of art. Their minute fibres are brought in contact with the elements of the soil, and they act upon them with a force peculiar to themselves.

546. "Red clover, and most other plants with broad leaves, draw largely for their sustenance from the air, especially when aided by gypsum. By its long tap roots, clover also draws much from the subsoil. The amount of carbon drawn from the air in the state of carbonic acid, under favorable circumstances of soil and crop, is usually very great, and when these elements of fertility have been buried beneath the surface of the soil, they are saved, and thus yield their fertility to the land; while such vegetation as decays on the surface will lose much of its value by evaporation and drainage. Red clover, when plowed under in its green state, will ferment very soon. Therefore by resolving the matter of plants into their elements, the soil will be well fitted for a succeeding crop of almost any grass or grain." (See Red Clover in the Chapter on Grasses, hereafter.)

Hon. GEO. GEDDES, in his Report of the Agriculture of Onondaga Co., N. Y., says, in relation to clover as a fertilizer in that county: "The Agriculture of Onondaga Co. is based on the red clover plant, (*Trifolium Pratense.*) It is used for pasture, for hay and for *manure.* Strike th s plant out of existence, and a revolution would follow that would make it necessary for us to learn everything anew in regard to cultivating our lands. What the value of our soils would be without red clover we will not attempt to conjecture. We have this most valuable treasure, and we appreciate it. The large kind is cultivated with us but little, and is considered of less value than any of the small kinds, both for hay and for pasture. But where it is wanted for manure only, it is sometimes preferred, on account of its heavy growth. The roots run deep into the soil, so that a single per-

fect plowing will bring it into the most satisfactory condition. Some of our best farmers plow their fields deep once in a few years; and then shallower plowing of this clover sod will show the long tap roots that have been pulled up from the sub-soil by the plow, which will project above the surface all over the field, looking quite like dead weeds. These roots have transferred the fertilizing matters of the lower soil to the surface. When our fields need improving, we turn the clover crop under; and repeat the operation until there is sufficient fertility to allow us to carry the clover off the field. The oftener we can fill the soil with roots and plow the tops under, the sooner we expect to get our land in a condition to crop with grain. A very considerable part of the cultivated land of this county has never had any other manuring than this clover and gypsum. And yet its fertility is not diminishing. Fields that are distant from the barn are rarely treated to anything but clover and gypsum. These fields are not cropped with grain as often as those that have the benefit of barn yard manure are. But they are manured at a much less expense. We sell our herd's grass, (*Phleum Pratense,*) and feed our clover. The reasons for this are, the city buyers will pay more per ton for herd's grass than for clover. And we long ago come to think the clover worth quite as much as the herd's grass to feed. This system of manuring with clover and gypsum has been carried on more than sixty years, apparently without any injurious effects on the soil, from which wheat, Indian corn, barley, oats, hay and pasture had been constantly removed during that period of time."

THE MOST PROPER TIME TO PLOW CLOVER UNDER.

547. Some farmers contend that the best time to turn under a crop of red clover is when it is in full bloom. The reason assigned for this period is, a larger amount of fertilizing material in the stems and leaves at that stage in the growth of the clover than at any other period. But there have been objections urged on this point. And one is, that although there may be a greater amount of fertilizing material in the stems at that

period, still there is such a large proportion of saccharine matter in the stems at that stage of its growth, that its decomposition has a tendency to increase the acidity of the soil or make it sour, which is very unfavorable to the luxuriant growth of any kind of cereal grain.

548. On the other hand, it is contended that it will be best to allow the clover to arrive at as complete maturity as possible, without losing any of its substance, before it is plowed under. And we feel assured that all good farmers who will investigate this subject thoughtfully and scientifically, will coincide with this theory. The reasons for it are both cogent and philosophical.

549. When red clover is allowed to stand until the seed is formed and the blossoms begin to change in color, there is then as much substance—and perhaps more—in the stems than there is at any other period in the growth of the plant. And reason teaches us that there has been a large amount of the very best fertilizing matter drawn from the soil to form the seed, which, when it has been turned under the soil and decayed, will be better for promoting the luxuriant growth of grain or grass than the best manure that can be applied to the soil. And by allowing the clover to stand until it has matured to that degree, the saccharine matter will have undergone so much change, that there will be no danger arising from its rendering the soil sour. And it has always been a question with myself, whether this acidity or sourness, to which writers allude so frequently, is not more imaginary than real. It will require a far greater amount of green vegetable matter to produce any perceptible acidity in the soil than we are accustomed to suppose. And, furthermore, it does not look very reasonable that an amount of vegetable matter so small as would be turned under the soil, in one crop of red clover, could possibly, during its gradual decomposition cause any perceptible acidity, unless the soil were already very sour. Let farmers raise red clover as large as it can grow; and turn it under the soil. And if it be done at the period just mentioned, they need have no fears concerning injurious acidity arising from the decaying clover. (Read Par. 619.)

VALUE OF WOOD ASHES.

550. Different kinds of wood, when burned, will produce ashes of quite different value, not only for promoting the growth and fructification of crops, but for culinary purposes. And if farmers only knew their value as a fertilizer, there would be no ashes wasted, neither would there be any for sale, except by those people who have no soils to improve or crops to raise.

551. A distinguished writer on agricultural chemistry, in a communication to the *Cultivator*, says: "Several salts are necessary for a full growth and maturity of a wheat crop. In using the superphosphate of lime, the farmer uses but *one* of the salts necessary for the perfection of the wheat crop. But in the use of ashes, the farmer applies to his land, besides several salts of potash, more or less of several other salts, no less valuable, according to the kind of timber from which the ashes were produced. Ashes from beech contain nearly twenty per cent. of the salts of phosphoric acid. According to the analysis of De Saussure, one hundred pounds of ashes would be sufficient for the production of 3,820 pounds of straw. But besides the other salts of potash, the ashes either furnish, ready prepared or produce after being put upon the land, a good supply of the silicate of potash—a salt as necessary as any other salts of potash, or even as any salt of phosphoric acid. But the ashes, besides furnishing several important salts, may perform another office in the economy of agriculture no less important. In the preparation of compost they may be used as a solvent, to convert into important manures many other things useless without being dissolved. And this too without destroying any of their efficacy as salts. They give compactness to light sandy soils, and render heavy clay soils light and friable. They serve, too, to neutralize whatever superabundance of acids there may be in any soil."

552. Every observing farmer has noticed how luxuriantly grass or grain of any kind usually grows where a brush heap or log heap has been burned; and also how superior the grain usually is, both in quality and quantity, which has grown on such places.

This consideration establishes, beyond a doubt, the fact that unleached wood ashes are excellent fertilizers ; and are of more real value to a good farmer, when they are applied to a crop, than when they are sold for the purpose of making potash.

553. Unleached ashes are far superior to leached ashes ; because they furnish a large supply of fertilizing material, which makes the straw more stiff than it otherwise would be. Therefore if the straw of cereal grain can be rendered much more stiff by sowing a few bushels of wood ashes per acre, of course there will be a much greater yield of grain if the straw can be kept erect, than there would be if the straw is so limber that it falls down before the grain is harvested.

554. Ashes, whether leached or unleached, are very valuable for promoting the growth of any kind of grass, when they are sowed broadcast over the fields ; and Prof. Liebig recommends sowing ashes on meadows, for the purpose of increasing the quantity of grass for hay. On some soils, ashes appear to exert almost a magical influence, in promoting the growth of cereal grain, as well as the growth of the grasses.

EXHAUSTING CHARACTER OF ASHES.

555. Wood ashes, either leached or fresh, in some places can be obtained in large quantities and at reasonable rates, especially at the pot and pearl ash factories. Leached ashes contain but little potash compared with the unleached ; yet they have in their composition all the inorganic or ash constitutents of our cultivated crops, and their application to light dry soils generally exhibits very favorable and marked effects, much improving their moisture-retaining qualities, and highly favoring the growth of corn, grain, &c. But farmers should always bear in mind that the tendency of ashes, lime, plaster, or even guano, when applied alone, is to hasten the exhaustion of tillage land—or rather, it is the increased "crops," or what is taken off the soil in the removed crops, that exhaust it. Therefore their use should always be accompanied with farmyard manure, prepared muck, or the turning in of green manure, such as clover, buckwheat and

556. I recently met with an instance in New England where a farmer had brought his land to a high state of productiveness by applying large quantities of leached and unleached ashes. But he recently told me that he had discontinued the practice of applying ashes, as they appeared to exert no influence on his crops. He had grown little but hay for market for several years; but it was evident that the ashes would not maintain the fertility of his soil without the aid of some other manure.

THE QUANTITY OF ASHES PER ACRE.

557. There is no definite quantity of either leached or unleached ashes which may be set down as the proper amount to be applied on an acre. There is no danger of sowing too much of either leached or unleached ashes. But when they are scattered on young turnips or on young plants, there is danger of applying so much, that the potash in them will destroy every leaf that it may come in contact with.

558. Leached ashes are often hauled from a distant potashery when they are quite wet. If not spread out immediately, they should be under cover until they are dry enough to be sowed. Some farmers haul them when they are quite wet, and spread them with shovels. But more time will be required to spread them uniformly in this way than it would require to dry them first; and, more than this, their effect will not be as good on the crop when they are spread wet as it would be if they were sowed, unless great care were exercised to spread them very evenly.

THE WAY TO SAVE WOOD ASHES.

559. There is great danger from fire breaking out from ashes, wherever they come in contact with wood of any kind. Sometimes a whole pile, barrel, or bin of ashes will burn over the second time, if they have not already been burned twice while they were in the stove. For this reason, when a lot of ashes containing live coals are deposited among cold ashes, combustion of the ashes often takes place, and the fire reaches the wood.

560. Ashes should never be deposited in wooden pails, boxes or barrels until more than a week *after* they have been removed from the fire-place. Many people deposit them in old sugar hogsheads, barrels, or wooden boxes, or make a bin by the side of the fence for them. But thousands of people have lost their dwellings by such an unwise practice. Where one has spare room in a dry cellar, there is no better place than that for keeping wood ashes, by pouring them in a conical heap on the flagging, or in one corner, or against the wall. A bin with brick or stone sides, in a stone or brick smoke house, is also a good place, but rather expensive. Some people are accustomed to make a conical heap of wood ashes on the ground in a back yard; and to erect a shelter of loose boards over them, to carry off the rain. But unless the surface be sprinkled with water occasionally, high winds will blow many of them away. It matters not *how* or where wood ashes are kept, if they are not allowed to leach, blow away, or to communicate fire to buildings.

THEORY OF THE ACTION OF ASHES.

561. SPRENGEL, a writer on agricultural chemistry, remarks, that "The action of all ashes is two-fold, partly due to the soluble, and partly to the insoluble. The chloride of sodium, or common salt, the carbonate and sulphate of potash are soluble, and produce immediate effect on the crop; but the phosphates and the silicates, as well as carbonate of lime, require time to dissolve and benefit the crop. (See Liquid Manure, par. 480.) Hence, it has been observed, that some *lands* are permanently improved by ashes, and some *crops* are immediately benefitted by them.

562. It is to the silicates, as well as to the large quantity of lime, magnesia, and phosphoric acid which it contains, that common wood ashes owe the more permanent effects upon the soil, which it is known to have produced. The two-fold action of ashes may be more familiarly expressed by saying that the action is *mechanical* as well as *chemical;* although the *mechanical* action of ashes on a soil is so infinitely small, that we are scarce-

ly able to perceive any benefit at all arising from its source. All the insoluble portions of any kind of fertilizers exert a mechanical influence on soils. But as soon as those insoluble atoms become dissolved by being exposed to the influence of the weather, they are in a proper condition to perform their office in a chemical manner when they come in contact with the roots of plants.

VALUE OF LEACHED ASHES.

563. The idea is very prevalent among most farmers, that *leached* ashes are of little or no value as fertilizers. But nothing is more erroneous. The leaching process only deprives the ashes of the portions which are soluble while that process is going on. After the ashes have been thrown from the leach, the insoluble portions continue to dissolve for a long time after they have been leached. Therefore leached ashes very frequently have been known to exert almost as good an influence in promoting the growth of plants, immediately after having been applied to a crop, as if they had never been leached. And the reason for this was, the phosphates, silicates, and carbonate of lime continued to dissolve after they were thrown away as valueless. Farmers should always remember that ashes are valuable as fertilizers even after they have been leached for a long period of time. The sooner leached ashes can be removed from the leach to the soil, the more valuable they will be in promoting the growth of any kind of crops.

FIRE-FANGED MANURE.

564. There is such a large amount of ammonia, and so little water in the manure from horse stables, that it will heat and become fire-fanged, in a few days, if it is not kept wet with water, or liquid manure. As long as manure is kept wet, it will not fire-fang. That manure which has been allowed to remain in a body, until it has become fire-fanged and mouldy, is little better than a lot of corn cobs. All the fertilizing material has escaped from it. Thousands of farmers throw the manure from their horse stables in a large heap, instead of spreading it around

the yard as it should be, where it will be mingled with the manure; and before it is hauled to the field it is almost worthless because it has become fire-fanged. And it is a most surprising fact, that thousands of very intelligent men, in other respects, do not know that it injures manure to become fire-fanged. I have met with many men who said they had always supposed that it was good for manure to undergo such a process of fermentation.

565. The manure of neat cattle is not very liable to fire-fang but sheep manure, under close sheds, will often become fire-fanged, unless it is kept moist by the application of water or liquid manure. The true reason why horse stable manure heats so soon is, that horses usually consume much more grain —generally oats—than any other animals. Therefore there is a greater amount of nitrogen or azotized material in it than there would be if they consumed nothing but hay. There is also less moisture in it than there is in the droppings of other animals, which facilitates rapid decomposition, soon resulting in fire-fanged, or almost worthless manure. When horses are kept on hay and roots, their manure will not heat very much sooner than the manure of sheep and neat cattle.

566. Horse manure from the stables of hotels and large liveries will almost always fire-fang before it can be removed from the yard. And as it is hauled along the street, the fertilizing gasses may be seen escaping in the form of steam. The manure of such stables is very rich in grain-producing material; because the horses are kept on unground oats, from which they seldom extract half the nourishment. But in order to keep the fertilizing substances from escaping, such manure should be spread thin with cattle manure, or muck or mellow earth should be mingled with it to absorb the rich gasses.

567. Farmers should remember that this pungent odor, which is perceived in horse stables, which often makes his eyes fill with tears, and which makes him sneeze as if he had taken a pinch of snuff, is *ammonia*, which is one of the very best fertilizers in the world for any kind of plants. And when the manure heap, or

the manure of his stables imparts this odor, he may think that he is losing money faster than he is earning it.

HOW TO PREVENT THE ESCAPE OF AMMONIA.

568. Water or dampness is the best absorbent of ammonia that the farmer can avail himself of. So long as manure is kept wet, there will be no danger of losing any portion of the fertilizing material by its escaping in the form of gas. If water be applied to a pile of horse manure that may be sending out a cloud of vapor during its decomposition, it will immediately arrest the decomposition, and no more of the fertilizing material will escape in a gaseous state. But care should be exercised in applying water to manure, not to apply more than it will retain by absorption. If too much be applied, of course the fertilizing salts, or ammonia, will be carried away in the liquid that may flow from the heap of solid manure.

569. The stables of horses are sometimes sprinkled with gypsum, for the purpose of retaining the ammonia. But a large quantity of gypsum would be required to absorb as much as would be retained by a little water; because gypsum will not absorb but very little until it has been dissolved. And by referring to Gypsum, paragraph 580, it will be seen that it requires about 640 times its weight of water to dissolve it before it can absorb ammonia. Gypsum is no better to absorb the ammonia of manure than any other powdered substance until it has first been dissolved.

570. This fact will account for the disappointment that many farmers have met with when they have applied gypsum to their manure for the purpose of absorbing the volatile ammonia, and to retain it until the manure should be deposited where it could promote the growth of plants. (See Gypsum as a Disinfectant, par. 587.) Water is the best and most convenient absorbent of offensive odors, which are highly charged with ammonia, emitted from the evacuation of sick people who are unable to leave their rooms. By putting two or three quarts of water into the vessel that is to receive the evacuation, every unpleasant odor will be

retained in the water. Whereas if the vessel contains no water, the room will often be filled with almost an intolerable stench. So it is with stables. If stables be scraped clean, and then drenched with a pail of water, it will cleanse and purify them, and absorb more ammonia than a liberal sprinkling of gypsum, lime or any other disinfectant in the form of powder.

571. Vegetable mould, peat, muck and such like substances are excellent absorbents of ammonia, if there be a proper amount of moisture, not in the dry powder, but with the liquid to be absorbed. There may be tons of dry muck in the stable; but it will not absorb the ammonia unless the ammonia be first mingled with some liquid and brought in contact with the muck. For this reason, dry muck, or finely pulverized peat, or clay, when in the state of a dry powder, will absorb a vast amount of ammonia when it is deposited where it will absorb liquid manure.

572. Every good farmer knows that a thin covering of damp —not wet—soil on a pile of any offensive substance will absorb all the offensive odors arising from it, and thus fertilize the soil. A few inches in depth of damp soil will absorb the stench emitted from carrion, which would fill the air with unwholesome effluvia for a good distance from it. But *dry* soil will not absorb the volatile substances unless they be first united with a liquid. Therefore water, or a liquid which is for the most part water, is very essential—indeed it is absolutely necessary—in order to absorb and retain the fertilizing volatile ingredients of a stercorary or stable.

ILLUSTRATIONS FROM LIFE, CONCERNING AMMONIA.

573. We read in Deuteronomy, 23:13, what command the Creator gave to the Jews for the purpose of keeping the atmosphere pure, where there was such a vast host of people encamped in a body which occupied the entire ground for several miles in circumference: "And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith; and shalt turn back and cover (with earth) that which cometh from thee."

574. In the above instance, we can see and appreciate the efficacy of a thin sprinkling of earth in absorbing nocuous and offensive odor—for the most part ammonia—which would have rendered the whole atmosphere unhealthy had this precaution not been observed. Another instance which is familiar to almost everybody is, the manner in which cats dispose of their ordure, by excavating a small hole in the ground and covering it with earth, which effectually absorbs the ammonia, which always renders the droppings of such animals so exceedingly offensive to our nasal organs. Another instance, which is familiar to most farmers, is that of sprinkling the foulest and most offensive slop holes, near the back door of some dwellings, with a thin stratum of mellow earth, which will absorb all the offensive effluvia.

THE VALUE OF SOFT SOAP.

575. How much fertilizing matter may we suppose there is in a barrel of soft soap? It is true that the quality of soft soap may differ in chemical constituents quite as much as two different kinds of soil may differ in fertilizing matter. But in a barrel of good soft soap, which has been made with potash and good grease, there is enough soluble fertilizing matter to produce at least half a ton of good hay, or several bushels of good grain, were it properly applied to the soil.

576. We would think it a very wasteful practice to throw away all the soap that may be used in the family of a farmer during one season. Still, how many there are who have practiced this very thing for many years in succession! How many have been to the expense of making costly drains to carry off to some stream their soft soap, for which their crops have suffered, more or less, every season.

577. After a barrel of soap has been through the wash tub, it is more valuable as a fertilizer than it would be before it was diluted for the purpose of washing clothes. Were soft soap, or hard soap either, applied to the soil, it must necessarily be thoroughly dissolved with rain water before it could promote the growth of plants. Therefore after it has been dissolved in

the wash tub, it is in the very best condition to be applied to the soil for the purpose of promoting the growth of grass or of cereal grain. The value of soap will depend on the amount of potash and grease of which it has been made. Both of these will be found to be very valuable fertilizers, whether they are applied to grape vines, fruit trees, to grass, grain, or vegetables in the kitchen garden.

HOW TO USE SOFT SOAP AS A FERTILIZER.

578. There are a number of methods of applying the fertilizing matter in soap suds to the soil, either of which may be adopted. The chief idea is, to get the potash and grease, after washing with the soap, into the soil, where it will promote the growth of plants; and to do it in the most feasible and economical manner. Some farmers place a molasses hogshead on a stone boat near the kitchen, where all the suds will be conducted into the bung hole; and when it is full, a team is hitched to the stone boat, and it is drawn where it is needed; and two or three plugs are pulled out of the end, and while the team is moving, the liquid flows out.

579. Another way to dispose of it is to carry it away in large pails. Another way is to conduct it from the kitchen to a heap of muck or compost. Still another good way, which we have practiced with our soap suds is, to conduct all the slops to a large hogshead set in the ground in the garden, when the fluid is applied to the plants broadcast, with a garden engine, or with a hydropult, or with a watering pot. When applied to vegetables, it makes them very fair and tender, and will usually promote a very large growth. It will have the same effect on grass and grain that unleached ashes does—it will increase the quality and the quantity of the crop. (See Ashes, par. 550)

GYPSUM—PLASTER—SULPHATE OF LIME.

580. Gypsum, or as it is more popularly denominated, *plaster*, is found in vast quarries like limestone. It is broken into fragments weighing a pound or so, with heavy hammers, and then

run through an iron cracker which reduces it to small chunks like gravel, after which it is ground into powder with mill stones, very much as grain is ground into meal. Sometimes it is ground very fine, as it always should be; and sometimes it is very coarse, which is very objectionable. When it is ground fine, it will act immediately on the crop; whereas if it be coarse, it will benefit the crop next season far more than the one that may be growing when it is sowed.

581. The young farmer should understand that gypsum, or plaster, must be dissolved before it can promote the growth of any plant. Therefore the finer it is ground the sooner it will be dissolved by rain and moisture; and thus be prepared to aid the growth of his crops. As soon as it has been dissolved, the particles which are in a liquid state will be carried down by the rain to the roots of grain or grass. Now, who does not perceive, at a glance, the great importance of having it ground as fine as may be practicable before it is sowed?

HOW GYPSUM OPERATES.

582. Almost every chemist who has written about the action of gypsum has advocated a different mode of action. Therefore it is rational to conclude, that but very little is really known about the matter; and what little they profess to know is more guesswork than anything else. But I believe that the theory of its action, which is most approved, is, it absorbs and fixes the volatile ammonia, which substance enters largely into the formation of plants, and which always promotes a very luxuriant growth.

583. It is a consideration of little importance, however, as to the *manner* of the operation of gypsum. If it produces good effects on crops, it is not worth while to trouble our brains too much in inquiring *how* it acts. If we give proper attention to such considerations and circumstances as will aid its action, as well as those which *prevent* its action, we shall be better prepared to use it, as a fertilizer, understandingly, and with good effects on crops.

584. It requires from four to five hundred times its own

weight of pure rain water to dissolve it before it will be prepared to produce any effect on plants. Then, after the powder has been dissolved, it must be carried down to the roots by rains, before it can exert any influence in promoting the growth of any plant. We are not in doubt about this matter—chemistry or no chemistry. (See Liquid Manure ; Par. 480.) These considerations will teach us more of the importance of having gypsum reduced to the very finest powder ; because these little coarse grains of gypsum will require a long time to dissolve.

THE WAY TO APPLY GYPSUM.

585. The roots of plants will not come to the surface of the soil after the gypsum. It must be carried down to the roots ; or be placed where the rootlets could reach it. Therefore when a handful of gypsum is thrown down in a heap—as it usually is applied—near a hill of corn, all the fertilizing material will be found within the compass of only a few square inches. And a moment's reflection will convince one, that if the handful were spread thin all around the hill, the roots on every side of the stem absorb the fertilizing substances when they are carried down by rain. If a handful to a hill were spread evenly over a space one foot in diameter, before the seed is dropped, the roots would come immediately in contact with the plaster ; and it would produce more than twice or thrice the good effect that the same amount will if it were simply dropped in a heap on the surface of the soil.

586. One good reason why gypsum exerts such a marked influence in promoting the growth of young clover is, the seed vegetates near the surface of the soil ; and as soon as the roots begin to spread, they come directly in contact with this fertilizing material, which the gypsum has prepared for the growth of young plants. Therefore the young farmer should understand that the gypsum must be deposited where the roots can have access to it. Where it is applied to grass or grain that has been sown broadcast, the gypsum should be scattered broadcast also. But where the grain is in hills, it will be best to sprinkle it around

them, and not sow it broadcast. And it is important to spread it thinly over a large surface; because if it be deposited in heaps, as it sometimes is, only a limited portion of the roots will be benefitted by it.

GYPSUM AS A DISINFECTANT.

587. Gypsum has often been recommended as an excellent deodorizer or disinfectant. In order that any substance may operate as a disinfectant or a deodorizer it must be in a fluid or gaseous state. Deodorizers and disinfectants must either absorb or neutralize in some manner those odors that are offensive to the smell. Solid substances—like gypsum—cannot absorb but a very limited amount of ammonia until it has been dissolved with water.

588. Therefore when gypsum is strewed in stables, for the purpose of absorbing the ammonia, it cannot absorb but very little of it while it remains in a powdered condition. But if it comes in contact with water or other liquid enough to dissolve it, then it will be fitted to absorb any offensive odors within its reach.

589. Many years ago chemists directed farmers to strew gypsum in their privies, for the purpose of absorbing the ammonia, and thus keep the air sweet and pure. Therefore many people erected their privies contiguous to their dwelling houses, confidently flattering themselves that a little sprinkling of gypsum would keep their apartments pure and sweet. But they soon found that there was but little efficacy in gypsum for such a purpose. The reason for it was, the gypsum was not first dissolved.

PLASTER OF PARIS.

590. The question is frequently asked, what is the difference between "Plaster of Paris and Gypsum?" Chemically speaking, there is no essential difference between the two kinds. Plaster of Paris is usually white; while gypsum is of a dark greyish color. But their chemical constituents are the same; and they

would operate exactly alike when applied to the soil. Plaster of Paris is an article of commerce which is used in the arts for taking casts and for plastering houses. In Paris, France, where originally it was extensively used for making mortar, for plastering houses, it goes by the name of plaster. But in other parts of the continent it is called gypsum. And the more common name for it in America is *plaster*. Nova Scotia plaster is the same thing, with the exception of certain impurities in it.

PROF. S. W. JOHNSTON ABOUT PLASTER.

591. "The character of the soil must necessarily greatly affect the operation of gypsum as a fertilizer. A soil that is already rich in sulphate of lime, or gypsum, of course cannot be greatly benefitted by the addition of more. A poor, light or exhausted soil, deficient in mineral plant food, as phosphoric acid, potash, &c., cannot be expected to become fertile by the application of gypsum; because this substance cannot supply those matters which are wanting; and without which no plant can flourish. Cold, wet, heavy and impermeable soils are usually almost unaffected by gypsum; and sometimes its use has been apparently disadvantageous on them. But porous soils, either sandy or loamy, which readily dry after rains, and which are well dunged, experience the most benefit from plastering. Excess of moisture and *poverty* of the soil are the chief hindrances to the action of gypsum."

DOES PLASTER EXHAUST THE SOIL?

592. *Does plaster exhaust the soil?* This frequently asked question is easily answered by the word *no*. A soil is never exhausted by what is added to it. But always by what is removed. But a little explanation is needed, for although plaster cannot exhaust the soil, plastering usually is *followed* by exhaustion, and for the simple reason that by its use nothing but sulphate of lime is added, while phosphoric acid, potash, silica, &c., are removed. A purse soon gets empty if eagles are constantly taken out, though cents be now and then put in. The *crops* which plaster enables the farmer to remove from the soil exhaust it. Sup-

pose that a few bushels of plaster raise the yield of clover upon a field 10 per ct.; then 10 per ct. more of phosphoric acid, potash, &c., pass from the soil into the crop than would have passed had no plaster been used. If plaster only be added, then the field will be exhausted in one-tenth less time than if nothing at all had been applied. In both cases the total amount of vegetation produced until exhaustion supervenes will be the same, and the amount of exhaustion the same. In the one instance the final result might be reached in 10 years; in the other in 9 years. The difference is merely one of time. If benefit is to be derived from the use of plaster, it must be accompanied with other manure, or its action, however good at first, will ultimately cease. Manuring a poor soil with nothing but plaster is attempting to sustain vegetation on plaster alone; and this, like feeding children on little else than arrow-root, is a stupendous folly. It is trying to build brick houses without brick. Plants cannot be made of sulphate of lime any more than men can be made out of starch. "Out of nothing, nothing comes."

IMPORTANCE OF TEXTURE.

J. J. Thomas, in an excellent article on the "Effective Action of Manures," says:

"Far more important than the mere presence of fertilizing ingredients, or even the *chemical condition* of those ingredients, in many cases, is their mechanical texture and degree of pulverization. We have elsewhere given an instance, furnished by one of the most eminent scientific and practical cultivators of our country, where the complete crushing of the clods of an adhesive soil, and the grinding together with them into powder the manure applied to the land, produced an effect upon the subsequent crop *five times* as great as the ordinary operation of manure. How absurd it must be to make strict calculations on the result of a given quantity of yard manure, without ever inquiring into the mode of application—whether, on the one hand, by spreading in large, unbroken lumps, carelessly and imperfectly plowed under, and in a condition wholly useless for

plants, or even detrimental in case of drouth—or, on the other, by a thorough harrowing of the soil and manure together, before turning under and a repetition of the operation when necessary afterward for complete intermixture. We have known the most admirable results by this practice, where nothing but fresh, coarse manure could be obtained for succulent garden crops, and nearly a total failure under like circumstances without its performance. Even the time of year that manure has been carted on the land, has sometimes had an injurious bearing on the success of its application, simply by the packing and hardening resulting from traveling over its surface when in a wet and adhesive condition. It is a perfectly self-evident truth, that a mixture of unburned bricks and clods of manure would afford immeasurably less sustenance to the fine and delicate fibers of growing plants, than the same mixture ground down together into a fine powder. Hence it may be reasonably believed that the general introduction and free use of pulverizers, as the most effective harrows, clod-crushers, and subsoilers, assisted by tile-draining, may be of greater benefit to the whole country than the importation of a million tons of guano."

LIME—OXIDE OF CALCIUM.

"The use of lime without manure
Will always make the farmer poor."

593. Properly speaking, lime is composed of *calcium* and *oxygen*, which is denominated the oxide of calcium. Calcium is a white shining metal, and the oxygen is a gas which exists in the atmosphere and in all solid and liquid substances. Oxide of calcium, or lime, is obtained by heating limestone in a kiln for several days to a bright red heat, for the purpose of driving off the carbonic acid which is in the limestone. Therefore, when we speak of lime, the correct idea is, that substance which remains after limestone has been burned sufficiently to expel the carbonic acid. This is called *quick-lime*, or unslacked lime. After water has been applied to unslacked lime, it will evolve a great heat, and be reduced to a fine powder. In this state it is properly called *caustic lime*, or hydrate of lime. When lime has

been exposed to the air, it will absorb moisture, which will slack it. Lime in this condition is called partly a hydrate, and partly a carbonate of lime. Lime that has been air-slacked for a few months will lose much of its fertilizing properties. Therefore the sooner it can be applied to the soil and covered with a sprinkling of earth, the more effective it will prove in promoting the growth of crops.

WHAT KIND OF SOILS MAY BE BENEFITTED BY LIME.

594. Chemists tell us, that soils known to be fertile, and in a high state of productiveness, "may contain no more than one five hundredth part of lime;" or a very critical analysis of such soil would detect only a *trace* of lime; and that according to this computation an acre of soil six inches deep would contain from one to two tons of lime. Those soils that are deficient in potash may be greatly improved by the application of a good sprinkling of lime. When there is a large amount of vegetable matter in the soil, lime may be applied with good effect. When the soil is of a granitic character, and has been cultivated for many successive years, a sprinkling of lime will exert a beneficial influence on its productiveness.

595. The correct way for ascertaining whether a soil may be benefitted by the application of lime is to experiment with a few small plots in various parts of the farm. In this way a farmer can satisfy himself beyond a doubt, whether lime will render his soil any more productive or not. On clayey soils, or those of a peaty character, lime will usually have a good effect. Farmers need apprehend no danger of applying too much lime to any soil. If it will not improve its fertility, it will not injure its productiveness.

HOW MUCH LIME PER ACRE.

596. Some writers have recommended to sow from one hundred to five or six hundred bushels of lime per acre; while others, under quite different circumstances, have stated that from ten to sixty bushels will be found the most proper amount for an acre. My own views on this subject are, that if a soil really

needs a heavy coat of lime, and it is at hand, let it be applied in a bountiful manner. But if lime is not plenty, and is quite expensive, it will be found better to apply, say six or eight bushels per acre every year, than to sow a very large quantity at one time.

597. When large quantities of lime are applied at one time, very much of the effect which it is designed to produce will be lost on the crop. But if a given quantity be applied to the soil for promoting the growth of each crop, the application will be much more judicious and the effects on the crops more apparent. There can only a small quantity of lime act upon a crop in one season; and if a large quantity be applied, its effects may be lost, or it may have no good effect on the soil. The skillful farmer must exercise some good judgment of his own on this point; and not be led to adopt an erroneous practice in the application of lime to his soil.

EFFECTS OF LIME, AND MANNER OF OPERATION.

598. Chemists tell us that "lime assists in pulverizing the soil by acting *chemically* on the silicates therein, dissolving out a portion of the silica and liberating potash and soda." For this cause, heavy applications of lime on some granitic soils that were not very productive have increased the productiveness to a great extent. J. Hyatt says: "The beneficial effects of lime depend very considerably on the assistance which is rendered by the carbonic acid of the atmosphere and of the light rains. It acts both chemically and mechanically. It acts mechanically, by rendering heavy, clayey soils more light, and by diminishing their tenacity, thus rendering them more friable and porous. When it is applied in large quantities, it will assist the decomposition of organic matter in the soil.

599. When there is an undue amount of acidity of any kind in a soil, a good sprinkling of lime will rectify it, and thus furnish a large supply of food for plants. Lime may be applied to potatoes with good effect on almost every kind of soil; and when the soil is very tenacious, if it be well drained, the lime will exert a

very good influence in promoting a healthy growth; and will render the potatoes more healthy and mealy than they usually are when they have grown on tenacious and heavy soils.

600. When there is such a large proportion of vegetable matter in a soil that crops of cereal grain will be all straw, and so large that it falls down before the grain has matured, a top-dressing of lime will exert a chemical influence on the soil, by which the straw will be rendered more inflexible or stiffer; and at the same time it will act on the grain—forming material in the soil, and thus increase the quantity of grain.

601. Lime will also improve the *quality* of cereal grain by furnishing nourishment for the plants that will make kernels of a more clear color, having thinner skin and more and better flour. This will be found particularly true where the soil is of a kind that will produce a great growth of straw, such as some kinds of swampy table land or river bottoms, which are very deep and destitute of sand, gravel and clay.

602. Lime will have a very good effect almost always on old pastures; and the experience of many reliable farmers on this subject is, that lime will improve both the quantity and quality of the grasses which grow on them, and thus greatly improve the products of the dairy, whether for butter or cheese. There are but very few soils, in pasture or in grass, that may not be improved more or less by sowing on them lime and wood ashes. And those fertilizers will usually be found very valuable on our western prairies, that have been cultivated for many years in close succession.

GAS LIME.

603. Large quantities of caustic lime are used at the gas works of our cities in making gas, which is really worth more for agricultural purposes as a fertilizer, after it has performed its office at the gas works, than it was before it was used in the purifier's. But farmers have not learned this fact. Therefore vast quantities of it are thrown away and wasted at the works, which might be used, with much profit, in promoting the growth

of crops, which in most instances would cost only the expense of hauling.

604. It is thrown out of the purifiers in a powdered condition, usually charged to its highest capacity with ammonia. An officer in the Edinburgh Gas Company, Scotland, says: "I believe that waste gas lime is equal in efficiency to fresh lime for most of the purposes aimed at in its use in farm lands. I sold all the lime thus produced at a gas work in Forfarshire for sixteen years to several farmers, who uniformly expressed their satisfaction therewith. One very usual application of it was its mixture with the 'wrack'—viz., the large piles of weeds and tangled roots of grass cleared off the fields annually. On being composted in this way, the lime gradually killed all the vitality of these weeds, and returned them to the land in way of manure. It also served the purpose of opening up stiff clay soil, being first spread over the surface and then plowed down. But the chief and most beneficial use of gas lime is found in its admixture with farm-yard manure at the time it is applied to the fields. This is explained by the fact that the lime from gas-works, while retaining all its original properties as a hydrate of lime, has acquired, in addition, a large amount of sulphur, much of which is *free*, and when openly exposed is taken up readily by the oxygen of the atmosphere. This sulphur, so readily parting from the lime, enters into combination with the volatile ammoniacal elements of the fresh manure, retaining them in the form of sulphate of ammonia, to be afterwards taken up gradually by the crop to which it has thus been applied. It is in the first and last mentioned application that gas lime has proved most beneficial in those cases coming within my own knowledge. It is not equal to newly burned lime shells for breaking up stiff clays."

LIME—THE BASIS OF GOOD HUSBANDRY.

605. J. J. Thomas writes in the *Country Gentleman:* "Lime possesses other properties, however, besides that of neutralizing acids. One of the most remarkable is the power to absorb putrescent manures, and to hold the fertilizing essence till it is

wanted for the crop, through every vicissitude of the seasons, and through indefinite periods of time. There it is locked up; and nothing at common temperatures but the energy of a growing plant can unlock it. Lime has therefore been styled the basis of all good husbandry. It stores up the manure that is not immediately wanted for future use—a kind of *save-all*. When the supplies from the barn-yard are spread and plowed into a soil that is nearly destitute of lime, the growing crop catches a part of its virtue; but a very large part escapes, and very little will be left for the benefit of those that succeed. I had been used to such soils until I removed to my present farm; and was then agreeably surprised to see how much more durable were the effects of stable manure. My fields were limed by the deluge. Unwholesome vapors and villainous smells are also absorbed by lime; and some places once remarkable for insalubrity have been changed in their character by liming or marling the fields around them. Nuisances are converted into manures. A striking illustration of this principle is contained in the following account from the Essay on Calcareous Manures.

606. "A carcase of a cow, killed by accident late in the spring, was laid on the ground and covered by about 25 bushels of broken shells, with 45 bushels of earth, chiefly silicious. After the rains had settled the heap, it was only six inches thick over the highest part of the carcase. The process of putrefaction was so slow, that several weeks passed before it was over; nor was it ever so violent as to throw off any effluvia that the calcareous earth did not *intercept in its escape*, so that no offensive smell was ever perceived. In October, the whole heap was carried out and applied to one-sixth of an acre of wheat; and the effect produced far exceeded that of the calcareous manure alone, which was applied at the same time on surrounding land. The same valuable work contains a caution to the farmer which may save him from a dangerous error. 'He is not to suppose that calcareous earth can enrich a soil by direct means. It destroys the worst foe of productiveness, [acidity,] and uses to the greatest advantage the fertilizing powers of other manures; *but of itself it gives no fer-*

tility to soils, nor furnishes the least food to growing plants.' In other words it is the strong box for treasure, but not the treasure itself. Lime also possesses the property of making sandy soils closer and firmer, and clayey soils lighter. It is a mean between these extremes."

PRECAUTIONS IN USING LIME.

607. As lime is of a very caustic nature, and will destroy the leaves of plants when it is brought in contact with them ; and as it will injure the germs of seed, it is very important that the young farmer should understand how to use it in an intelligent manner. When lime is applied to growing potatoes, or young Indian corn in the hill, or to turnips, or any other plants, it is important that it should not be deposited on the leaves, or in the sheaths of the plants, as it will soon destroy the leaves, and thus injure them more than they will be benefitted by its application. The correct way to apply it, is, to sprinkle it thinly, on the soil, about the young plants. If it be thrown in small heaps near them, it will be liable to do more injury than it will do good.

LIME SHOULD BE KEPT NEAR THE SURFACE.

608. Mr. J. Hyatt, in an Essay on Agricultural Uses of Lime, has said : "Highly caustic lime [or lime that is just slacked] should not be introduced into direct contact with seed in the hill or in the drill. Caustic lime should not be applied with yard-manure, nor with any manure that contains much nitrogen. Very coarse, unfermented manure is not so liable to be injured by it, especially, if it be covered with earth or muck which will absorb any liberated gases. Lime should not be used in a wet state ; nor should water be applied too fast when it is being slacked, as it will make lumps of paste of the slacked portions, which will not spread readily when it is sowed. Unslacked lime should not be applied to the soil, as it will be liable to unite with the soil and form hard lumps of mortar. If a soil is not well drained, either naturally or artificially, lime will not exert any marked influence in promoting the growth of a crop ; and if a dressing of lime

were applied to a wet soil of clay, it would do much more injury than good. Lime is used to purify privies, and other foul places; but as it liberates the ammonia, it destroys the excellence of substances that are designed for manures. For this reason lime should never be used in making poudrette."

609. It should be borne in mind, that lime must not be buried deep in the soil; therefore it is a wrong practice to plow it under. Where a large quantity is applied to the soil at one time, it may be well to harrow it in. But, as a general rule, it is best to sow it, and let the rain wash it into the soil. R. L. ALLEN, in the *American Farm Book*, says: "To give lime its fullest effect it should be kept as near the surface as possible; and for this reason it is well to spread it after plowing, taking care to harrow it well in. Then it should be allowed to remain in grass as long as may be profitable. The weight of lime, and its minuteness, give it a tendency to sink into the soil. Therefore, after a few years of cultivation, a large portion of it will be found to have got beyond the depth of its most efficient action. When lime is used, this tendency gives additional value to the system of under draining and subsoil plowing, which enables the atmosphere and roots of plants to follow the lime, thus prolonging its effects and greatly augmenting the benefit to crops. It should be spread on the soil immediately after taking off the last crop, so as to allow the longest time for its action before the next crop."

PREPARING LIME FOR SOWING.

610. When it is to be applied in large quantities, it may be dropped in small heaps in the field, and allowed to slack in air, rain and dews, when it may be spread with shovels. But when only a few bushels are to be applied per acre, it is quite important to have it all thoroughly slacked, so that it will not clog the machine when it is being sowed, or will not remain in lumps if it be sowed by hand.

611. The best way that I am familiar with for preparing lime to be sowed is, to spread it on the cellar bottom, or under some shed, or in some building, about one foot deep,

where the wind will not blow it after it is slacked. A cellar is the best place, as it will be a little damp. There will be no danger of its producing fire if it is not more than a foot deep. In this place let it air-slack for several weeks. Once in a few days let it be forked over, for the purpose of bringing the large lumps to the surface. Sometimes large chunks will need a little sprinkling of water to aid the slacking process. If it has been well burned, it will slack well. But when it has been poorly burned, and when there is much flint and other impurities in the stone, they may be raked out with a fine-toothed iron rake if the lime is to be sowed with a machine ; or if it is to be sowed by hand, these impurities will do no harm.

612. Lime should be sowed in a damp, lowry day, when there is no wind to blow it away from the place where it is desirable to have it fall. And if it be slacked in a damp place, it will absorb moisture enough to prevent its flying at every breath of air; and at the same time it will be in a better condition to be applied to the soil than if it were in a caustic state—just slacked.

LIME AS A MANURE.

613. J. J. Thomas in the *Annual Register* of Luther Tucker and Son, when alluding to "lime as a manure," says : "As the effects of lime last several years, it makes very little difference at what season it is applied, provided it is well pulverized, so that it may be evenly spread, and not in lumps, which can be of very little use. It cannot evaporate—it may sink into the soil, if copious and long continued rains occur before it becomes converted to a carbonate, which must be in a few days at furthest. After that, the carbonic acid brought down in rain may dissolve it very slowly, and in almost infinitesimal portions. The fact that the effect of a dressing of lime is sometimes known to last twenty years, shows that it is not easily carried off. If sown on grass, nothing further is necessary ; if on plowed land, harrowing may serve to mix it with the soil."

EXAMPLE OF SUCCESS IN LIMING.

614. The *Genesee Farmer* gives an account of a farm in Lancaster county, Pennsylvania, which has been one hundred years under cultivation, and during the last fifty years has been limed every ten years. It was much exhausted when the use of lime was first resorted to for its renovation; but the application of ten bushels per acre developed elements of fertility before unavailable in the growth of crops. After the lapse of ten years, the good effect of the lime disappeared, and a new dose of ten bushels per acre was again administered. The soil is a gravelly loam, and yields, with liming, thirty bushels of wheat per acre. Clover, a plant which feeds very largely on lime, is grown in rotation with the wheat, and is either turned with the plow or fed to animals whose manure is applied to the land. This is one of the most successful examples of liming that has met our notice; and on other soils the result might be quite different.

615. After penning the foregoing paragraphs, I met with a good article in the *American Agriculturist*, written previous to my connection with that paper, which says: "The precise action or use of lime is not as yet a settled question. Theoretical agricultural chemists have claimed that, since lime is found in the ashes of most crops, it is one of the most essential constituents, and must therefore be found in the soil, or must be applied, if not already there, in order to supply the elements of the plants. A single illustration is conclusive on that question. The farm on which we were brought up, though a diluvial or loam soil on the surface, is literally filled with limestones, and rests on limestone rocks, which often protrude through the surface. The well and spring water is so saturated with lime as to yield a thick coat of it upon the tea-kettle in a brief time. Yet burned lime and plaster (sulphate of lime,) have always been favorite fertilizers, because their application has *proved* to be profitable. Many thousands of bushels of lime have been burned from stones gathered upon the surface, and the burned lime has been applied right among the unburned stones with excellent results. The water flowing from the soil

is abundantly saturated with lime *in a soluble condition*, so that there can be no possible lack of this element for the use of the plants. On this point it may also be added, that in the analysis of many samples of water from wells and springs in all kinds and qualities of soils, and from various sections of the country, we have never yet found a specimen of water that did not contain lime enough to meet the wants of any crop.

616. The burning limestone simply drives off its carbonic acid, and reduces it to a fine or powdered condition, so that it is easily mingled with the soil. Simply grinding limestone would not remove its acid and render it caustic; this is only accomplished by great heat. No rule can be given for judging as to whether any particular soil will be benefitted by lime. Experience has proved that it is often useful both on clays and on very sandy loams where there is but a very limited supply of lime naturally in the soil; and that it is equally beneficial on soils half made up of limestone, pebbles, shells, and organic petrifications, which are composed chiefly of lime. Actual trials are the only sure tests of its utility or non-utility upon any particular soil. Moderate applications, at frequent intervals, seem to be preferable to heavy coatings at long intervals. A cold, heavy, sour soil may receive 30, 50, or even 100 bushels per acre at one time; but on lighter soils, 15 to 25 bushels are usually an abundant supply. To apply 50 or more bushels per acre on a light soil may decompose and use up all the organic matters in the first year, and render it sterile; while 15 bushels may prepare enough organic material to benefit the first crop; and the roots and leaves of that crop will add more organic matter for a succeeding crop. This may explain why lime has after a time been condemned where it was at first in great favor. We know one instance where the soil of a neighborhood was light and sandy. Lime was hauled 30 miles by teams, and very moderately applied—10 to 20 bushels per acre. The opening of a railway reduced the cost to 8 cents per bushel, and one farmer applied 500 bushels to five acres at once, expecting great results. The first crop was a good one, but the field

was ruined until a heavy coat of manure was applied to restore organic matter.

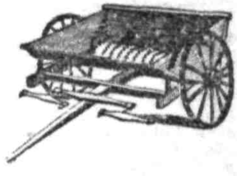
617. Large applications of lime on a heavy soil, and not thoroughly diffused through it, as when it is spread on the surface and plowed under, often settles in a layer and forms a compact bed through which the roots will not penetrate freely. We have seen many such instances, and nothing would grow well until a plow was run below to throw it upon the surface, and then the harrow used freely to break up and commingle the hard layer with the rest of the soil. Lime is perhaps the most important fertilizer we have, aside from barn-yard manure. It is useful on a large proportion of all the farms in the country, and may well be tried where it has not been used. Its effects, the best modes of application, and the *rationale* of its operation, should be carefully observed and studied by cultivators generally.

MODE OF USING LIME.

618. The best form of application is to sow *fresh slaked* lime in the finest condition possible, and immediately mix it thoroughly with the soil by harrowing and plowing. Some spread it upon the surface, and plow it in. The better way is to first plow the land, then sow the lime, and immediately harrow it in well. When spread in heaps, and left for days or weeks, it absorbs carbonic acid from the atmosphere, and is then far less active upon the vegetable material within the soil. When fresh slaked with water, it is an almost impalpable powder, and can be much more thoroughly scattered and diffused through the soil. If it lay in heaps upon the field, or is air-slacked, it becomes carbonated, and though still friable or in a powdered condition, the particles are a thousand times less minute. Sown as a top-dressing, it acts upon a little of the surface, and some of it is washed into the soil; and we have seen good results from this practice, but the effect is far less than when sown fresh and immediately worked into the soil.

COOPER'S LIME SPREADER.

er, used extensively in some parts of Pennsylvania, and other States, and is considered to be a very effectual and easily managed implement. The advantages claimed for it are, that it saves labor and time, and does its work with inimitable evenness. It is an entire machine in itself, to which a pair of horses, oxen, or mules may be hitched, and a load carried, without waste, to the place where it is to be used, where it may be put into operation in half a minute, and will evenly distribute any desired quantity to the acre. It weighs no more than a common ox-cart, and will carry as large a load. It feeds itself, crushes and pulverizes all hard lumps except core. With it one man and team can do at least as much work as four men and two teams without it, while the evenness with which the work is done can in no other way be equalled. The machinery is simple and strong, not liable to get out of order, and very durable—the working parts being all made of iron. This machine is said to sow plaster and ashes equally well.



COOPER'S LIME SPREADER

COMPARATIVE VALUE OF COMMERCIAL FERTILIZERS.

620. The inqnriy is constantly being made as to the value of poudrette, nightsoil, superphosphate, and other commercial fertilizers, which are sold by the sack or barrel. If a person can obtain a genuine article, the good effect on crops resulting from the fertilizing influence of such manure will be readily seen. But manufacturers are so anxious to make a fortune in any such enterprize, that they often sell thousands of dollars worth of stuff for genuine fertilizing material that will promote the growth of crops no more than the same amount of street dirt. Indeed, it has repeatedly been reported by those who were good authority, that a large proportion of the commercial fertilizers that is sold in barrels is nothing but street dirt. An untold number of farmers have purchased a few tons of such manure; and after a year have reported that they have never been able to perceive any benefit

at all from its application. Such testimony shows conclusively that it is adulterated with an abundance of cheap and worthless material that is no better than common soil to promote the growth of crops.

621. Samuel Church wrote to the editor of the *American Agriculturist*, soon after I commenced my editorial career with that paper, that he saw it stated that stove pipe and water buckets were taken from night soil before it was prepared for poudrette. He then says: "I found *in* a barrel of poudrette a year or two ago, the following articles: coal cinders, ashes, burnt and unburnt bones and shells, pieces of earthen, stone, glass and china-ware, pieces of window and looking glass, pieces of black, blue, green and white bottle glass, pieces of tobacco pipes, bricks, lime and cement, shirt and other buttons, nails, feathers, rosin, peanut shells, piece of lobster's claw, pins, piece of comb, a dress hook, hair pins, shavings and pieces of bark, isinglass, a pair of sleeve buttons, a hog's tooth, a marble, whalebone, rattan, straw, fish scales, pieces of springs of hoop skirts, wire, leather, rags, egg shells, piece of slate, a carpet tack, matches, corn, oats, seeds of dates, oranges, watermelons, muskmelons, and raisins, two kinds of seeds name not known, cherry stones, saltpetre, a child's toy of turned wood, dead leaves, etc., etc., etc." A curious compost truly! And such *stuff*—yes, such worthless stuff as this, which is not worth hauling from the barn yard to the nearest field, farmers purchase at an exorbitant price, simply because some one has used a good article with excellent results. It is infinitely better for the farm, and more profitable for farmers, to feed out their coarse grain and make mutton, beef and barn yard manure, which they *know* will produce a good crop, than to sell it and purchase worthless street dirt, old tobacco pipes and pieces of lager beer glasses. Let me reiterate the thought, that farmers should aim to make their own manure; and never purchase the worthless stuff of commerce, unless they have some good assurance that they will receive a fair equivalent for their money.

DOCTOR VOELCKER'S TESTIMONY.

622. Dr. Voelcker, makes use of the following language in exposing "the tricks of the trade."

623. "If there ever was a time when the agriculturist had need to exercise especial caution in purchasing artificial manures, that time is the present; for the practice of adulterating artificial fertilizers, such as guano, superphosphate of lime, nitrate of soda, &c., has reached an alarming point. The increasing demand for these manures, their inadequate supply, the general favor in which artificial fertilizers are now held by farmers, the deficiencies of natural sources from which a really valuable manure can be prepared; disregard for the difference of the practical effects of a manure and its real money value; the difficulty of arriving in a single season at a positive conclusion with regard to its efficacy, and other similar circumstances, are fruitful causes of the shameful adulterations in artificials of recognised value, and of the many inferior or worthless new compounds which are found in the manure-market at the present time. It is well known, moreover, to all who have watched this state of the manure-market, how easily testimonials can be obtained even from high agricultural authorities, notwithstanding the comparative inferiority of the manure. These testimonials are often fictitious, and even when genuine, cannot be relied upon in estimating the real money value of a manure. Under favorable circumstances, the application of the most worthless manure occasionally is attended with an abundant crop; and as the dealer or manufacturer takes good care to select for publication only those opinions which are favorable to the sale of the manufactured article, and does not tell us how many expressions of opinion he has received, which, when published, would damage his business, it is evident that little dependence can be placed on printed testimonials. Indeed, the dealer or manufacturer has so many chances to reap a large profit for a season from the sale of an all but worthless article, that it is not surprising to find so many unscrupulous persons engaged in a course of fraudulent pursuits. Whilst thus, on the one hand, the

unsuspecting farmer is swindled out of his money, and runs the risk of losing his crops too ; on the other hand, enterprising, well qualified, and honest persons are deterred from employing their capital, energy and skill in an undertaking which, under more favorable conditions, could not fail to benefit alike the manufacturer and purchaser."

BARN-YARD MANURE THE BEST.

624. HON. A. B. DICKINSON, a noted farmer of Steuben County, New-York, said, in an address to a certain agricultural society : "With regard to manures, I lay it down as an axiom not to be gainsayed, that barn-yard is the best. It warms cold land, moistens dry, and dries wet land. It makes stiff, compact clay land mellow, and compresses and makes light soils productive. Every farmer should, therefore, not only make all he can, and save all he makes, but use it to the best advantage. It is necessary for every farmer to plow in a portion of his manure for roots, and in almost all cases on stiff clay soils, for corn. If plowed in for these crops, I would advise the use of a subsoil plow to follow after the common plow,—throwing manure in after the subsoil plow,—and then the plow need only run deep enough to get at the best of the surface soil, for the top soil, whether it be three inches or six, is the very best you have, and should be where your seeds are planted. If your land has been deep-plowed previously, and is sufficiently rich and deep enough for carrots, parsnips, or for corn roots, then the use of the subsoil plow can be dispensed with. (See par. 394 to 397.)

625. "No farmer can afford to plow in all his manure, and the less the better, as one load will enrich the soil, if spread on its surface, more than two loads will if plowed in. On this point I wish to be distinctly understood, as I am not only at variance with chemists and the professors of agricultural colleges, but also with government trial fields in Great Britain and on the Continent, and with some practical farmers nearer home. Yet I shall give my views with as much confidence as though no others were anywhere entertained; for if there is any one subject that I

think I understand, it is that of fertilizing the land. But I do not desire any man to take my say so, if I cannot give good and substantial reasons for "the faith that is in me," to inspire him also with confidence in it. A fair trial of my views is very simple. Take a field where the soil is as nearly equal as possible; divide it by furrows into lands of exactly equal size; plow in just double the number of loads of manure on the one that you spread on the surface of the next, and so alternate through the field.

626. The lands being struck out straight, and exactly the same size, seed down with some crop so that your grass seed will be sure to take. The next year when you mow it, cure the product and put it on the scales, and you will find that the one-half where the manure was spread on the surface, will give you as much or more hay than the other half. But this is not all; after the field has laid in grass for eight or ten years, the surface-manured portions will give you a much thicker and richer sod to plow under than those where double the amount of manure was plowed in. The reason is simply that top-dressing mulches and feeds the roots. And, as instances rendering my theory still stronger, let me tell you what I know. You may take sufficient of your poorest clay soil to spread one inch thick on a field, and plow that in. You would not perceive the least benefit from this, whilst an eighth or a sixteenth of an inch spread on the grass lands that have been impoverished by raising grain, would increase the crop of hay from one-eighth to one-fourth, and in ten years would make an increase in the thickness of the soil."

BLOOD, AND ITS MANAGEMENT.

627. The chemical composition of blood is nearly the same as lean flesh. There are saline substances, albumen, fibrin and other materials in it, of a highly fertilizing character. When employed as a manure, it exhales large quantities of ammonia, which promotes the growth of all kinds of crops.

628. The most convenient and economical way of saving it is, to have it absorbed by dry muck, saw dust, tan bark, or any

other absorbent that will retain it until it can be deposited in the soil. When it can be collected in large quantities at slaughter houses, the most convenient way is to let it run into a tight trough, from the floor where the animals are killed; and then remove it with a scoop shovel or pails to the muck bed. This should be under shelter, and quite dry, as damp muck will not absorb as much as dry. Spread the blood around on the muck, and shovel dry muck on it, until it is all absorbed. A bushel of gypsum to thirty bushels of muck may be mingled with it. As it dries out, it should be shoveled over several times, and kept from heating so as to injure it. In a few months it will be sufficiently dry to put in barrels or boxes; or it may be deposited in the basement of any building on a dry floor. The more charcoal there is mingled with it the better. When blood is managed in this way, it will make an excellent fertilizer for Indian corn, or almost any other crop; and after reducing it fine by crushing or running through a threshing machine, it may be applied broadcast or to hills by sprinkling it thin over an area of a foot or more in diameter where the plants are growing, or are to grow. This kind of fertilizer should always be covered with a thin layer of soil as soon as it is distributed, to prevent the loss of the ammonia in it. Whenever this compost emits an odor, as it often does when it is heating, the mass should be shoveled over and the lumps crushed. A sprinkling of water will prevent its heating.

VALUE OF SPENT TAN BARK.

629. The great excellence of spent tan bark consists, for the most part, in the *mechanical* influence which it exerts on the productiveness of the soil, and also in its great capacity to absorb the liquid manure of animals, which would otherwise never be saved and carried to the field. When pure tan bark is mingled with soils that are very compact, or in which pure clay or gravelly clay predominates, it makes them more porous and mellow, and increases their productiveness. But when it is mingled with soils that are already too light and porous, it has an injurious influence

on the productiveness of the soil. Therefore the young farmer will be able to decide, with almost unerring certainty, whether spent tan bark will or will not promote the productiveness of his soil. On moist farms, it will pay to haul it one or two miles, providing it is properly managed.

THE TRUE WAY TO USE SPENT TAN BARK.

630. If wet tan bark be spread in a stable or yard for the purpose of absorbing the liquid portions of manure, we shall find that it will take up but very little of it, because it is already so full of water that there is no room for any liquid manure. Therefore, unless it is nearly dry, before it is spread in the stable or yard, it may as well be spread directly on the soil, and thus save handling over twice. Spent tan bark ought always to be deposited in an open shed, where it will dry out before it is needed in the stable or piggery. Dry tan bark will absorb a great quantity of liquid manure, which will rectify the acidity of the bark ; and at the same time hasten its decomposition as soon as it has been mingled with the soil.

631. Dry tan bark will make excellent bedding for any kind of animals ; and it will retain what it has absorbed much better than any kind of straw. When it is used for bedding, a few bushels should be spread on the floor beneath the animal ; and as soon as it is well saturated with liquid manure, it should be removed, and a fresh supply placed beneath them. If tan bark be used for littering sheep, it should be covered with damp straw, to prevent its getting into their wool. Dry tan bark is valuable in a piggery, as it will increase the bulk of swine manure, and thus make the manure go farther, when it is mingled with the soil, or when it is used as a top dressing for grain or grass, which is very desirable, and important also, in distributing manure that is as concentrated as are the droppings of fattening swine. The manure that is made when spent tan bark is used will be a very excellent fertilizer to apply to the soil when it is being prepared for a crop of roots of any kind, as it supplies the plants with an abundance of those salts which are essential for

promoting their luxuriant growth. What has been said of spent tan bark is equally true of saw dust, turning shavings, and short shavings of planing mills; and they should all be used in the same manner. But if they be wet they cannot absorb liquid manure.

THE HUSBANDING OF MANURES.

632. The New York State Agricultural Society discussed the subject of manures at one of their winter meetings; and the following extracts are a summary of the discussion. It shows that American farmers are beginning to appreciate the value of manure. Farmers must first see and feel the importance of an object before they are prepared to act correctly and understandingly on the subject:

"I. Where sufficient has been reserved for arable lands, barnyard manure may be spread upon pastures and meadows under the following restrictions:

a. "If spread early in the spring on pastures designed for *immediate* use, it should not be the droppings of that species of domestic animals intended to be placed in the pastures.

b. "It should never be spread upon meadows in the spring, as the coarser parts will be caught by the hay-rake and mixed with the hay, imparting to it a musty smell, if not tainting and poisoning it with fungus.

c. "It may be evenly spread on meadows at any time after harvest and lightly harrowed or bushed, especially if the after-math is heavy, so that the grass may not be smothered.

d. "The weather should indicate the absence of high winds, the approach of moderate rains, or the presence of copious dews, so that the ammoniacal portion of the manure may not be lost.

e. "On rapidly sloping lands, a heavier top-dressing should be applied near the summit, unless furrows such as are necessary in irrigation are made, so as to prevent the manure being washed with heavy rains to the bottom.

f. "In winter no manure should be spread on either pastures or meadows when hard frozen, even when most of the atmos-

pheric conditions above alluded to are present, *unless* the surface is or soon will be covered with snow, and then only on ground either level or gently rolling, so that in case of a thaw the melting snows may not render the distribution of the manure comparatively useless.

II. "Under a system of rotation of crops, as supposed in the question, the husbanding of manure is indispensable to thrift in farming, and is to be regulated according to the supply of litter and the method of feeding adopted.

III. "On farms whose principal staple is grain, the amount of straw is not unfrequently in excess of the feeding material reserved, and in such case it is necessary to spread it profusely over the barnyard, that it may be trodden down by cattle and sheep, and mixed with their droppings. In such cases it is sufficient that the barnyard should be dished or provided with one or more tanks for the holding of the drainage of the mass; that fermentation should be allowed to proceed until the straw is disintegrated sufficiently either to turn the mass into heaps (into which the liquid contents of the tanks are to be conveyed by pump and troughs,) or drawn out into the fields for spring and fall crops—of which method, as generally in all departments of the farm service, the labor that can be applied is the discriminating test.

IV. "Where from the scarcity of straw upon a farm, its high price in neighboring markets, or its being an element of food prepared for stock, it is necessary to economize its use, the system of box or stall feeding is to be resorted to, and husbanding of manures is determined as the feeding is either of animals to be fattened or reared.

V. "In the former case, neat cattle may be placed in boxes not less than 8 by 10 feet, the bottoms slightly dished with a view to drainage or being filled with muck or other absorbents, and the animals wintered with slight additions of cut straw as litter, so as to prevent the loss of hair and other cutaneous affections, (which proceed from the heating of straw if too liberally

supplied,) and the whole mass of droppings, &c., left until removed to the fields.

VI. "In the latter case, that of the rearing of young animals, a like method may be pursued, but if their value will admit of a greater regard being paid to cleanliness, &c., the box should have a slatted floor of oak or other durable strips 1½ inches thick, 3 inches wide, and ½ an inch apart, over a paved, clayed or cemented floor, inclined so as to carry the drainage of the box into gutters leading to a tank, and the manure removed as often at least as once in six weeks, placed under cover of a roof, either permanent or of boards battened, turning on pins, and moved by a long lever, as in sheds for drying of brick, the liquid manure (if not used separately) being pumped from the tank and conveyed by troughs over the mass so as to prevent fire-fanging. If used separately, the sheds are to be opened to occasional rains for the same purpose.

VII. "The manure from animals stabled in the ordinary way is to be treated as last described, and it is desirable that the manure shed should be constructed with access to it from a level below that on which the manure is deposited, so that in winter the manure may be carted out upon lands plowed in the fall, the fresh masses placed on top, preserving those underlying from being thoroughly frozen.

VIII. "When sheep are alone raised, they should be kept under sheds, with small yards connected therewith, and their droppings may be treated either as in the case of fattening or growing animals, in the discretion of the owner.

IX. "Where no portion of the manure is designed for top dressings of pastures, that of horses and neat cattle may be always advantageously placed under the same cover, their different capacities for developing heat operating favorably against over heating.

X. "As the value of straw as an article of food if cut up, mixed with feed, thoroughly wetted and allowed to stand in mass for a few hours, so as to develope heat, or if steamed, is at its lowest price worth at least twice as much for food as for the

manure resulting from its use as litter; where beds of muck or peat exist on a farm they should be ditched, and afterwards pared, so that by the use of these materials when dried, the straw may be used as an article of food, a greater number of animals kept on the farm, and greater masses of manure made, and with a material more valuable that straw as an absorbent and fertilizer, and for the prevention of the droppings of cattle at a more uniform rate of temperature."

EXPERIMENTS WITH SURFACE MANURING.

633. James M. Garnett, a Virginia farmer, an excellent writer on agriculture, says: "I began penning my cattle late in the spring, and continued it until frost, in pens of the same size, moved at regular intervals of time, and containing the same number of cattle during the whole period. These pens were alternately plowed and left unplowed until the following spring, when all were planted in corn, immediately followed by wheat. The superiority of both crops on all the pens which had remained unplowed for so many months after the cattle had manured them, was just as distinctly marked as if the dividing fences had continued standing; it was too plain even to admit of the slightest doubt. A near neighbor, a young farmer, had made the same experiment on somewhat different soil the year before, but with results precisely the same. Similar trials I have made and seen made by others with dry straw alternately plowed in as soon as spread, and left on the surface until the next spring. In every case the last method proved best, as far as the following crop would prove it. The same experiment has been made by myself and others of my acquaintance, with manure from the horse stables and winter farm pens, consisting of much unrotted corn offal, and without a solitary exception, either seen by me or heard of, the surface application, after the corn was planted, produced most manifestly the best crop. Upon these numerous concurrent and undeniable facts my opinion has been founded, that *it is best to apply manure on the surface of the land.*"

634. Mr. Garnett contends that no loss of ammonia en-

sues from surface manuring; and in support of this fact asserts that if such were the case, such land as had been used as summer cow-pens, when plowed up and the dressings turned under, would have produced better crops than that which was left unplowed; but that in no instance did it do so. As a further argument, he reasons that the fertilizing elements of manure being soluble in water, more probably pass down into the soil, as well from their own gravity as from its possessing a greater attraction than does the atmosphere, and asks if plant food be subjected to loss by evaporation, and as this evaporation is constantly going on even when below the surface, why it does not impoverish the soil without any cultivation whatever? He claims—and he is certainly right in saying this—that it is only incessant culture without manure that produces either partial or total barrenness. We, too, believe in the superior advantage to be derived from surface manuring, but only when it is practiced within certain limits and under certain conditions of soil. On all light sands, and on sandy and gravelly loams, lands manured on the surface in the fall of the year, on fields that are level or nearly so, and before the frost imposes an impenetrable barrier in the descent of the soluble portions of manure, the crops so top-dressed will be decidedly benefitted. But on all soils containing a large admixture of clay, on all slopes and hillsides where the water passes off easily and rapidly in heavy rains, but little, if any, advantage will accrue. In all these latter cases the manure, to retain its fertilizing properties, must be plowed under.

635. In surface manuring, a distinction should be made between green long manure and that which has been well rotted. The former requires the chemical action that is constantly going on in the soil, in order to reduce to a condition that shall render it perfectly adapted to the nourishment of the growing crop. The latter, by fermentation, has already become sufficiently soluble for this purpose. Moreover, long manure, when plowed under, has also a mechanical effect on the texture of heavy soils; it renders such soils lighter, more porous; facilitates the percolation of rain water through them; renders them more retentive

of moisture, and at the same time allows a free circulation of air. Quite a number of years ago, but subsequently to the experiments which Mr. GARNETT describes, we also endeavored to test the merits of what might then have been styled the new theory of surface manuring. The soil was a poor gravelly loam which, as it fronted on a turnpike that was much travelled, we were particularly desirous of getting down to grass. It was hillside land, sloping with a tolerably easy grade to the north and east. During the latter part of summer a quantity of manure had been hauled out and piled up in a heap ready for distribution when the time for putting in the wheat crop should arrive. As the field was quite an extensive one, and needed very heavy manuring, the amount which had been collected when the period for plowing commenced was not more than sufficient to cover one-half of it at the rate of fifteen two-horse cart loads to the acre. Upon one-half of it the manure was spread accordingly, the remainder being plowed and seeded to wheat and grass at the same time. Immediately after this work had been completed, we pushed forward teams daily to the neighboring city to haul our additional manures for the purpose of top-dressing the remaining half. As fast as the manure was brought from town, it was carted over the land and spread. Although due diligence was exercised, a considerable breadth of soil was left uncovered when the heavy frosts set in and locked everything up. The work of manuring went on nevertheless, until, finally, the entire field had received the quantity per acre allotted to it. We now awaited the result. It turned out after harvest as follows :—That half of the field where the manure had been plowed under produced a fine crop of wheat ; but it was greatly injured by the rust—the grass, however, was tolerably well set, though rather thin. On that portion which was manured on the surface, before the heavy frosts came on, the stand of wheat was also good, and was less affected by the rust. The stand of grass was better than on the half on which the manure had been plowed under. On the remaining portion of the field, which was top-dressed during the winter, the wheat produced badly, and the grass did not

large dead animals with a coating of only six inches of loam ; not the faintest indication of the decomposition below ever reached the surface. On the other hand, the soil which forms the bottom of manure yards is not found even within a few inches of the surface to be at all enriched by the piles of fertility which rest upon it. The true rule for burying manure is to place it just at such depth in the soil as the roots of the crop usually extend, which will vary with different plants. Some of the grasses, for instance, form a turf very near the surface, and hence an autumn top-dressing will soak in enough to benefit them essentially. Clover roots run deeper, and this crop is consequently but little benefitted by top-dressings when of much size, except so far as they operate in keeping the surface moist. The roots of fruit trees are still deeper, and they derive but little advantage, except from manures well spaded or worked in. They, however, possess an important advantage over annuals and perennial rooted plants ; by continuing in growth for successive years, those roots which happen to run into the region of fertility soon throw out numerous fibres, and secure an amount of nourishment of which annual plants, in consequence of their more limited powers of extension, are not able to avail themselves.

640. There are, however, not many crops which do not need the full depth afforded by ordinary plowing ; and hence the best practice for nearly all kinds of culture is to spread the manure well, harrow it most thoroughly, in order to break it as finely as possible, and at the same time to mix it intimately with the surface; then turn it under by ordinary plowing, and the lower half of the inverted earth will furnish a thoroughly enriched bed for the roots to penetrate. If a greater depth of fertility is needed than ordinary plowing affords, the coat of harrowed manure may be thrown under ten or twelve inches by means of a double mouldboard or Michigan plow ; (See par. 355,) and then another coat of manure spread, harrowed and plowed under by a light or gang-plow. The young plants of the crop are thrown rapidly forward by the upper stratum of manure, and at a later stage of growth are equally stimulated by the lower stratum. (*See Country Gentleman.*)

LIGHT CROPS AND ABUNDANT MANURING.

641. Farmers frequently complain that they have been greatly disappointed in the quantity of grain per acre, after having applied such liberal dressing of barn-yard manure; and they often inquire why it should be so, even when a soil is well drained and has not been impoverished by a long succession of exhausting crops. As a general rule this subject may be explained in the following manner: A liberal dressing of manure that has been made by animals that have consumed little or no coarse grain during the foddering season, will increase the quantity of grain but little. When a farmer has fattened a good lot of mutton or beef on coarse grain and oil meal, and has taken proper care of the manure, we never hear him complain that he manured highly and harvested a light crop of grain. The disappointment usually is in harvesting much more than was anticipated when manure is used which was made from fattening animals.

642. If we use the manure of milch cows, for example, which have subsisted on nothing but hay and roots, and a little buckwheat bran, their droppings will produce good crops of hay or of cornstalks; but the manure will be lacking in that material which will produce large kernels. Then there is another weighty consideration on this point. The manure may have been of the most excellent quality once; but by having been exposed to storms and sunshine in the yard, or by having been spread in the field for several hot and drying days in the spring, a large portion of the fertilizing material has evaporated. Although chemists assure us that there is a large quantity of oil in a ton of straw, still if farmers manure their land with it, that oil, which many suppose will increase the amount of grain, only promotes a good growth of straw. In the spring of 1863 I purchased a lot of manure—almost pure ordure—which was made by milch cows. The Indian corn and potatoes which grew where that manure was applied were unusually small, while the stalks and tops were exceedingly large. Many of the hills of potato tops, when stretched up, would reach six or eight inches higher than my head—five feet

nine inches. If we manure with grain, we shall get grain in return. If we manure with grass, hay and straw, we need not expect a very abundant crop of grain. I think farmers will find this correct the world over.

BONES, AND THEIR UTILITY.

643. Bones are the very cream, the life, the source of fertility of our best soils. Let all the bone-producing material be removed from our soils, and we could raise no grain, no grass, no cattle, no vegetables, no nothing; and the husbandman would toil without any assurance of even a poor compensation. Cattle, horses, sheep, and all other domestic animals, and even wild animals, are constantly picking the substance of which bone is made out of the soil; and farmers are annually carrying it away to market; and in many localities they have been picking for so many years, that bone has become "despot scace," as my old grandmother used to say, so that it hardly pays—and in many places does not pay to get it into an available shape for either the advantages of home or foreign trade. Tons upon tons of bone-producing substance are removed from our soils every season, not only in our beef cattle, pork, mutton, and other animals, but in milk, butter and cheese; and every ounce of it that is carried away impoverishes the soil.

644. In the cities of Chicago, Cleveland, Buffalo, New-York, and even in South America, bones are collected and bought and sold by the ton, and shipped to New-York, where they are sawed up, and crushed up, and then sacked and barreled up, and scattered all over the world. Old bones, new bones, and bones of all kinds are collected and assorted, and sold at prices according to kind and quality. The knuckle bones and fragments are all thrown into one pile, and sell for so much per ton; and the long shin bones and thigh bones are kept separate, and command a greater price than the knuckle bones, as the latter are worked up into buttons; and the fragments and pithy portions are crushed and used as a fertilizer of the soil.

645. Farmers in America are not half awake to the importance

of saving the bones that are wasted on their farms during the year, and of applying them to their soils. Every one hundred pounds of bones are worth not less than fifty cents when applied to the soil; and if the soil is well drained, they will be still more valuable. It will, no doubt, be interesting to farmers to know, not only how bone is employed as a fertilizer, but how they are used in some of the arts, and how they are prepared for agricultural purposes.

HOW BONE BUTTONS ARE MADE.

646. In most bone mills is a button manufactory, where all the bones that are sound enough are used up in the manufacture of buttons. All bones that have not been bleached to death in the weather are boiled to death in large kettles, to drive out all the grease and render them softer, so that the bone dust will not produce so much grain or grass; and farmers will be obliged to purchase more of it, and they will not wear out so many saws and drills in fitting them up; and then dried so that they will break to pieces sooner after we have sewed them on our garments. Vast quantities of bone-grease are sold at the bone mills, which would render the buttons much more durable, and the bone dust much more valuable as a fertilizer. If one good boiling does not appear to be enough, they are boiled again and again.

647. On one side of the shop are a number of circular saws, about eight inches in diameter, having very fine teeth, which are all hung over a water-trough, and the lower side of the saws revolve with a frightful velocity while hanging in the water. Bones are so hard that saws would be heated so hot in a few minutes as to spoil them, did they not run in water. The large ends of the bones are first sawed off, and then the long straight pieces are slit up into bone slabs, as logs are sawed into boards, about one-eighth or one-fourth of an inch thick, according to the kind of buttons to be made. One hand will saw about a barrelful of slabs per day. The slabs are then held in button lathes, and blank buttons are cut out of these slabs by a kind of centre-bit, somewhat like cutting wheels out of a plank. Now about a half bushel of these buttons are put in a polishing barrel, where they

are kept revolving for a few days, when they are carried to the drill presses, and one button at a time is placed under the drills, and two, three or any desired number of holes drilled in them at once, and almost instantaneously. After the holes are all drilled, about half a bushel of them are put into a polishing barrel, which revolves slowly, where they roll and tumble over each other for about a week, which polishes them completely, when some of them are colored and carried to the assorting room, where nimble fingers of children assort them and put them in papers.

648. All the saw dust, drill dust, and polishing dust is collected and barreled for market for fertilizing purposes; and if the saw dust which is collected in the water is taken out and dried properly before it begins to decompose, it is not injured by having been wet; but it is frequently rendered almost worthless by being allowed to remain wet until it has become nearly rotten. All the big joints and fragments are then run through the crushers, which are very strong-toothed cylinders of cast iron revolving together, between which the bones pass, ripping, cracking and snapping; and are carried in elevators to the story above, where all fragments that will not pass through sieves are brought back to the hopper, to be run through again and again, until they are all reduced to a given degree of fineness. The coarsest quality of ground bone is about like large kernels of rye and wheat. This quality of ground bone is usually put in barrels, while the finer qualities of bone are put in large sacks made of very coarse material.

ADULTERATION OF GROUND BONE.

649. Any way to cheat the farmers! Clam shells, oyster shells, and many other kinds of shells, which are of little or no value when compared with ground bone, are often worked in, which increases the profit of the bone dust dealer and diminishes the value of ground bone as a fertilizer. It is rather difficult, however, to work in much of such substances in ground bone of the coarsest quality, because it can very readily be detected; but among that which is ground very fine, a vast deal of ashes, plaster, and even dirt and loam and sand are worked in to increase the

weight, without much expense. Of course this has a great tendency to bring ground bone, and bone dust, and bone for fertilizers of any form, into disrepute.

650. Ground clam shells and oyster shells are of little value as a fertilizer when compared with good bones ; and when bone has been boiled until it is as poor as bone can be, and one-fourth of it is clam or other shells, those who purchase it as a fertilizer receive a very small compensation for their expense and efforts towards enriching their soil.

651. Bones are sometimes dissolved with sulphuric acid ; and then plaster, some ashes, loam and sand, or muck are mingled with them and worked over and over, until the mass is reduced to nearly dry powder, which is sold for about sixty dollars per ton. Could farmers procure acid at a reasonable compensation, and dissolve their bones at home, it would be a consideration worthy of their notice. But at the present prices for bones and labor it will hardly pay ; and for a farmer to pay sixty dollars per ton—the price demanded for this kind of fertilizer—and to pay freight on it and cartage, and the profits of an agent or two, will never pay.

652. On this subject of adulterating fertilizers, the editor of the *Rural Advertiser* says : "The articles which we *know* of having been mixed with so-called superphosphate of lime were "powdered anthracite coal," "anthracite coal ashes," and "Jersey marl." We have recently made another discovery of two articles, introduced into *bone dust*, and which could not be told by outward inspection. We do not give names, neither do we know where these adulterated articles are to be found, but that they are and have been offered for sale in Philadelphia there is no doubt. In one case, a friend of ours, who uses a considerable quantity of *quartz-sand* of a certain degree of fineness, was told by the party selling to him, that the finer *grade of sand* he was in the habit of selling to the *manufacturers of bone dust*, the demand for it being a *steady one*. Here was a rich development, truly. In another case, within a few days, a person came into an agricultural warehouse in this city to sell *ground oyster shells*. He brought a

sample to show, and we have it now in our store, for inspection by the curious. Its *color* and fineness would allow it to be mixed with bone dust without detection, from external appearance. He offered it at eleven dollars per ton, and said he *had been selling it to bone manufacturers*, but expressed a great desire to prevent this being known by the *farmers*. He said it was important to keep it from them; but that at the present price of bone dust it could be mixed *with great profit*.

DISSOLVING BONES IN ASHES.

653 There has been not a little said and written, in years past, about dissolving bones by putting them in damp unleached ashes. Thousands of farmers have made an effort to use up their bones in this way ; but have almost always failed. Ashes will seldom dissolve old bones ; and, as a general rule, old bones will remain in wet ashes as long as a piece of granite without being dissolved. This is particularly true of old bones that have been bleached in the weather for several years. If the bones of very young animals be placed in a barrel of best kind of wood ashes—the ashes from hickory or sugar maple for example—and kept in a warm place, most of them will, in a few months, become a soft pulpy mass, when dry muck or loam may be mingled with it, which will make an excellent fertilizer for any kind of grain or grass. But in case the ashes are made of bark or old pieces of rails or soft wood, a much longer time will be required to dissolve even fresh bones, if they are the bones of young animals, than most farmers will have patience to wait for. If a farmer must necessarily expend as much in preparing any kind of fertilizer as the extra amount of grain is worth which it will produce, he had better by far use some other substance which will cost less, and produce less grain, grass, or anything else, than to attempt to use crushed bones, notwithstanding their value as a fertilizer, when reduced to a fine powder.

BURNING BONES.

654. It is the practice with many farmers to put all the bones

which they can collect into their stoves and burn them until they will fall to pieces. But this is a very objectionable practice; because about one-third part of fresh bones consists of animal matter, which would promote a very luxuriant growth of plants as soon as it may be placed where the roots would come in contact with it. But burning the bones drives off all this valuable part into the atmosphere ; and it is lost to the proprietor ; and nothing will remain but the lime and some other ingredients which are not the best fertilizers.

655. Pulverized bones, after they have been burned, will be a tolerable good fertilizer on some soils ; but their chief excellence has been burned up. Consequently the effect on whatever crop they may be applied to will be hardly perceptible ; and their efficacy as a fertilizer will not be half as lasting as if they had not been burned.

THE WAY TO SAVE AND MANAGE BONES.

656. Every farmer should procure a large tub, or molasses hogshead, and place it at some convenient nook, and cover the bottom with two or three inches of muck or fine soil. Now, spread on leached or unleached ashes, two or three inches deep, Then let all the bones from the kitchen be thrown into this hogshead. Large shin bones and knuckle bones ought to be broken in pieces before they are put in. When there is a layer about six inches thick, cover them with a few inches in depth of ashes, Then spread on two inches of fine soil or muck, then one peck of gypsum. Now, let the mass be wet with soap suds occasionally. This mode of managing bones will answer on a limited scale. But where there are several tons of large bones, and a lot of horn piths, the only reliable way will be to crush them by machinery. If kept in ashes, dogs will not carry them away. In the course of a few months of warm weather, most of the small bones will be reduced to a soft, pulpy mass, when they should be shoveled out and mingled thoroughly with dry muck and gypsum, when it will be ready for use. The hard chunks that will not dissolve may be put into another batch. The alkali of

the ashes is the chief agent in dissolving the bones; and the muck and gypsum will absorb the gases that might escape.

657. In many of our large cities and villages, many tons of excellent bones might be collected for one-fourth their value. If a sugar hogshead—which would cost twenty-five cents—were placed near every slaughter-house, butchers would be willing to fill it with skulls and other bones in a short time, for a reasonable compensation. Poor boys would collect bones from house to house —as they do in our most populous cities—for about twenty-five or thirty cents per hundred pounds.

658. Horn piths may often be collected in large quantities, at tanneries, for a trifling sum; and many times tanners are pleased to have them taken away for nothing. Horn piths are not as good as some kinds of bone. But they are an excellent fertilizer; and are much better than some bones. If they have become very dry, they must be cut to pieces with an ax and ground, as ashes will not dissolve them.

EXPERIMENT IN GRINDING BONES.

659. Having one of JOICE's Starr grain mills, I collected a lot of bones which had lain in the woods more than two years, and put the mill in operation with two horses hitched to the lever. There were some large shin and thigh bones which appeared strong enough to break the mill to fragments; but they snapped and fell to pieces almost as readily as if they had been ears of Indian corn. I then put in jaw bones, teeth and all, and an entire skull, and they went through with very little power, I think not half as much as is required to grind Indian corn. I then took a very large new bone, from which the beef had just been removed, and it was reduced to small fragments as if it had been a piece of half-rotten wood. I then adjusted the mill to grind about as fine as bark is usually ground at tanneries. There is so much marrow and oleaginous matter in bones, that it would not be possible to get them through were the mill adjusted to grind them as fine as coarse meal. It is not necessary that bones should be reduced to a very fine powder, although the finer they

are ground, the greater the effect will be immediately on any crop. If they are ground coarse, their fertilizing influence will be felt on crops for years to come; and therefore nothing will be lost in the end by not having them reduced very fine. After a lot of bones have been run through the mill, the largest fragments can be run through the second time, and thus reduced as fine as desirable. I found that there is a great amount of marrow in large bones, even after they have lain bleaching in the weather for several years; and this has a tendency to cause the mill to clog; although mine never clogged but once in consequence of it, and then by letting up a little on the set screw the bones passed through freely.

660. "Will it pay to grind bones in this manner?" Most assuredly it will. I have not had a sufficient amount of bones to experiment with as I desire; but I have ground enough to satisfy myself that a span of horses will grind more than one hundred pounds in an hour with ease; and it could be performed when teams and hands would be idle, or by boys, for whom it would be fine amusement to see them reduced to fragments. And, more than all, one hundred pounds of such bones as farmers would collect and grind up would be worth more than twice as much as the ground bone of commerce. This that I have ground smells very strong, and is very rich in fertilizing material.

COMPOSITION OF BONE.

661. It has been shown by accurate examinations of animal bodies, that the blood, bones, hair, &c., as well as all the organs, contain a certain quantity of mineral substance, without the presence of which in the food these tissues could not be formed. Blood contains potash and soda in combination with phosphoric acid. The bile is rich in alkalies and sulphur. The blood globules contain iron. The principal ingredient of bones is phosphate of lime. Nervous and cerebral substance contains phosphoric acid and alkaline phosphates; and the gastric juice contains free muriatic acid.

662. The importance of manuring with bones must be obvious

to all. The bones of man and animals in general have their origin from apatite (phosphate of lime) which is never absent from fertile land. The bone earth passes from the soil into hay, straw and other kinds of food, which is afterwards consumed by animals. Now, when we consider that bones contain 55 per cent. of the phosphates of lime and magnesia, and if we assume that hay contains the same quantity of these salts as wheat straw, then it follows that 8 lbs. of bones contain as much phosphate of lime as 1,000 lbs. of hay or wheat straw; and 20 lbs. as much phosphoric acid as 1,000 lbs. of the grain of wheat or oats. By manuring an acre of land with 60 lbs. of fresh bones we furnish sufficient manure to supply three crops (mangel wurzel, wheat and rye) with phosphates. But the form in which they are restored to a soil does not appear to be a matter of indifference. For the more finely the bones are reduced to powder, and the more intimately they are mixed with the soil, the more easily are they assimilated.

NATURE'S MANNER OF FERTILIZATION.

663. It is contended by many theorists that *nature* applies all manure on the surface of the soil, without being covered; and consequently that must be the better way to apply manure, as *nature* never makes any *mistakes* or does *things wrong*. If *nature* were to drive a vast system of huge plows over our hills and dales and through our dense forests, turning furrow slices two or three hundred feet wide and a hundred or more feet deep for the purpose of burying all vegetable matter, would not these very abettors of such a theory conclude that manure should be buried in the soil? As the fertilizing substances must be taken up by the roots of plants, common sense would seem to argue that manure should be slightly covered with earth, so that the fertilizing substances may be carried downwards by the rains, where they can be taken up by the roots of plants. Every good farmer knows that when manure is buried in the bottom of deep furrows, when Indian corn is to be planted, the corn grows slowly until the roots have reached the bottom of the furrows where the

manure is deposited. There is no very great objection to spreading manure on the surface in late autumn; for the damp weather and rains will leach most of the fertilizing substances into the soil. But even then, the effect would be far greater, and much more lasting, could the manure be covered with a thin stratum of earth. Nature does not plow and sow, nor reap and mow; because there is no necessity for it. But nature *does* practise fertilization on a grand scale, all over the country; and the *modus operandi* is worthy of the highest regard of those farmers who apply their manure in the spring as a top-dressing. Nature never applies her fertilizing material in the spring, except as it is brought down by April showers. Nature spreads the leaves of trees and all other vegetable matter in autumn. And although it is not plowed under, the decaying vegetable matter is carried into the soil by rains as fast as it is washed out of the organized bodies that have retained it during the hot weather. Were the leaves of trees and other decaying vegetable matter spread out in the spring, the hot weather and drying winds would carry away a large proportion of the fertilizing matter. But "nature" does not spread her fertilizing vegetable matter till autumn, when every thing is tending into the earth.

BOUSSINGAULT'S ANALYSIS OF MANURE.

664. According to the analysis of manures by Messrs. PAYNE AND BOUSSINGAULT, barn-yard manure of all kinds contains more water than any thing else. Thus 100 lbs. of solid cow dung contains 86 lbs. of water. 100 lbs. of cow's urine contains 88 lbs. of water. 100 lbs. of horse dung contains 75.4 lbs. of water. Urine of horses contains 79 lbs. of water. Pig dung, 100 lbs., contains 81.4 lbs. of water. Sheep dung, 63 lbs. of water in 100 lbs. They compute 125 lbs. of solid cow dung to be equal to a 100 lbs. of farm yard manure, and equal to 73 lbs. of horse dung. 15 lbs. of horse urine is equal to 125 lbs. of cow dung, or 91 lbs. of cow urine. From these figures, the young farmer will discover how important it is to save the liquid manure of the stables. 68 lbs. of dung water, as it flows from the manure yard,

is equal to 100 lbs. of farm yard manure in its wet state. 167 lbs. of wet wheat straw, or 650 lbs. of dry wheat straw, is equal to 100 lbs. of farm yard manure. 83 lbs. of wet buckwheat straw, or 361 lbs. of dry, is equal to 100 lbs. of dry farm yard manure. Wheat chaff is much more valuable for manure than wheat straw. 74 lbs. of oak saw dust, dried in the air, is equal to 235 lbs. of wet wheat straw. Some kinds of saw dust is more valuable than oak saw dust. 68 lbs. of cider-apple refuse, dried in air, is equal to 100 lbs. of wet farm yard manure [this is doubtful.] Such manure is excellent when mingled with the soil around fruit trees. 13½ lbs. of liquid blood is equivalent to 650 lbs. of dry wheat straw. 6½ lbs. of good bones, not heated, are equivalent to 109 lbs. of wet farm yard manure. If these figures approximate only to one half of this computed value, all such substances are worth saving for manure.

HOW TO PITCH MANURE EASILY.

665. As pitching manure is laborious work, it is important to render the labor as easy as possible by the exercise of skill in handling the fork or shovel. The accompanying illustration of a laborer pitching manure with a long-handled fork, will illustrate the manner of performing easily with skill what is usually done by main strength. To pitch easily, thrust the fork into the manure, and make a fulcrum of one knee for the handle to rest on. Then a thrust downward with the right arm will detach the forkful from the mass of manure, and elevate it from one to two feet high, by the expenditure of little

PITCHING MANURE.

muscular force. By using a fork like a lever, as here represented, a man can pitch larger forkfuls, and more of them, with far less fatigue than he can without resting the handle across his knee. When manure is pitched with a short-handled fork, the force required to separate the forkfuls from the mass, as well as for lifting it on the cart, must be applied by the muscles alone. This often renders it fatiguing and back-aching labor. Moreover, when a man pitches with a short-handled fork, he applies his force at a very great disadvantage, as he is required not only to lift the entire forkful with one hand, but to thrust downward with the other one sufficiently hard to balance the force expended in detaching and elevating the forkful of manure. Consequently the arm nearest the manure must expend muscular force sufficient to raise the weight, say, of two forkfuls. This principle is quite as applicable in using the shovel as the fork. By resting the long handle across one knee when shoveling, keeping the arms stiff, the body erect and straight, a slight thrust of the body and knee will force the shovel into the earth with the expenditure of little force. These suggestions, and the illustration, will enable any one to expend his muscular force to the best possible advantage in using both manure-forks and shovels. (See How to Handle Shovels, Vol. I., p. 244.)

FORKING BARN-YARD MANURE OVER.

666. This is essential to rotting well. When corn-stalks, straw and ordure of animals are all trod down firmly during the winter and spring, the air is effectually excluded; and the material will not rot until it has been forked over, were it to remain there for a year or more. If it is loosened up, so that the air can circulate among it, the entire mass will decay in a few weeks, so that it will be easy to pitch and spread it.

667. Now, the most expeditious way of pitching manure up clean from the bottom is, to do the greater proportion of it with a strong horse-fork. Set up three long poles, as for pitching hay on a round stack, and make a hole down to the bottom of the manure first; then thrust the tines of the horse-fork under

the manure, and turn it up in large rolls, and tear it to pieces with hand forks. Horse forks are of great service where the manure is very long. After it has rotted, a man, or two men can pitch much faster by hand. If barn-yard manure remains in the yard all summer, it should always be forked over to facilitate the decay of corn-stalks and coarse straw. But it should be protected. Some farmers pitch long manure on the wagon with horse-forks; but I never could perceive that the practice would pay; because a horse-fork will not hold as much as a horse is capable of elevating. It is easy for any one to try the experiment, which will soon satisfy all anticipations or doubts on this subject.

DISTRIBUTING MANURE IN THE FIELD.

668. Some farmers dump a whole load in a place, with the heaps two or more rods apart. Such a distribution of manure makes double work in spreading it, when it is spread as it should be. (See Spreading, par. 669.) My practice always was to make calculations first, how large a surface my manure will cover of a given depth. After one row of heaps is distributed about eight feet from one side of a field, drop the rows just five paces apart, and the heaps but a few feet apart in the rows. It is far better to make many small heaps than a few large ones; because the manure will be more evenly distributed, and will require much less time to spread it. The rows of heaps should never be placed more than one rod apart. There are just 160 square rods in one acre. Therefore it is easy to calculate how many loads to apply to every acre. When coarse manure is hauled to a field in autumn, or during the winter, and is not to be plowed in until the next spring, the heaps should be made of a conical or pyramidal shape, so that less surface will be exposed to the rain and snow. The practice of hauling manure on a field, and allowing it to remain in broad heaps, bleaching for six months, as thousands of farmers do, who would lose their equanimity if told that such a practice is not in keeping with successful and thrifty farmers, deserves the severest denunciation.

SPREADING MANURE.

"He lightly shakes it, with an agile hand,
From the full fork, the saturated straw." COWPER.

669. Most laborers make very slow progress at spreading manure; and handle their forks most stupidly awkward. A fork with a short handle like a spade is better for spreading manure than one with a long handle. As a forkful is thrown, the fork should be skilfully shook, in order to separate the manure as fine as possible as it leaves the fork. When a laborer pitches the manure from the heaps, and then goes and knocks the forkfuls to pieces, more time will be consumed in spreading it than most farmers are willing to devote to so small a job. Whether manure is applied very bountifully or rather sparingly, the young farmer should see that it is spread very evenly over the whole ground, and not left in large bunches, nor twice as thick as it should be, where the heaps were made. If the manure is fine, the proprietor should see that a laborer uses a shovel to remove the fine manure at the bottom of the heaps. Disinterested laborers will often leave so much manure where the heaps were made, that the crops will grow so large at these spots as to fall down and not mature well, because there was too much manure ; while not ten feet distant the soil was so poor that the crops are barely worth harvesting. See that every square foot of ground has a uniform sprinkling. If the manure has lain in heaps for a long time, remove the entire heaps, as enough will have been carried down by the rain to fertilize the soil where the heaps have lain. When manure is to be plowed in, spread it no faster than the ground is plowed, as much of it will waste by evaporation.

670. A good farmer penned the following thoughts for the *Country Gentleman:* "The man that spreads it must have brains, as there will be some portions of the field that need more than others to make the meadow even. He should stand on the load while spreading, as he can see much better from that position where and how to spread the manure ; and besides he can spread it faster in this way than when it is unloaded in piles about the

field. I never permit a man to unload in piles for the purpose of making haste for dinner, rain or night. He may unhitch from his wagon to make haste for anything, but manure is too precious for top-dressing to be piled up in the field. No man can apply it to grass as it should be, after it is unloaded in piles, for the reason that all that is left in the pile must be spread; and if not sufficient, must answer; and still worse, the fine which would be left in the bottom of the wagon is pulled off into the pile, instead of being taken as it should be to some portion of the field where strawberries, moss, or some other pernicious things are trying to run the grass out; which latter course is as much preferable to harrowing and scarifying the meadow as it would be to feed the proper food to stunted, scurvy cattle whose hides have grown fast to their bones from starvation, instead of scarifying their hides to give them a start. I never saw a skillful top-dresser whose meadows 'run out;' and I never saw a man, or one that had ever seen one of that class of farmers, whose sheep had 'run out' or deteriorated in his hands.

After the manure has been spread from the wagon, it should be spread over again after a rain. Eight tons to the acre are not sufficient to cover the whole surface; but the manure can be spread much more nicely when wet than when dry. There are two objections, however, to drawing when wet. One is, the manure is then much heavier to handle; and the other, which is by far the greatest, is, that it cuts up and injures some soils almost as much as the manure does good. The second spreading should be made to touch every place which was not reached the first time, even if some places have to be slightly uncovered to do it, as the rain will have washed out enough to give all the plants a taste, where it lay in the first place. It is better to spread small quantities of manure often over the surface of the whole farm than to put large quantities on some places, letting other portions go without any, except for a few crops, which require quick rich soils before the farmer has time to enrich his soil sufficiently by the slower process. This I know is against the teachings of Liebig and Way, as well as most of the agricultural writers of ancient and modern

times. But I have the practical experience of our own country to sustain me, which after all is the surest teacher."

EXPERIMENT WITH PROTECTED AND UNPROTECTED MANURE.

671. Lord KINNAIRD instituted the following experiments to show the difference in value of protected and unprotected manure ; and the difference in the result would have erected suitable sheds for protecting much more manure than was used in the experiment. A field of 20 acres, of very equal quality, being a rich loam, naturally dry and in good heart, was selected for the experiment, and divided into two equal portions. The manure was applied at the rate of 20 cart-loads per acre. The whole field was planted with potatoes ; the seed all of one kind. All showed no difference in growth till the first week of July, when a decided superiority began to manifest itself in the half of the field manured out of the covered yards. The vines on the portions of the field manured from the exposed yards began to decay by the latter end of July, while the other portion of the field still retained its strong dark green. The crops were taken up on the 1st to 4th of October, and after careful measurement and weighing of two separate portions in each division the result was as follows :—

With Uncovered Manure.

				tons.	*cwts.*	*lbs.*	
1st measurement—		1 acre	produced	7	6	8	of potatoes.
2d	plot	1 do	do	7	18	99	do

With Covered Manure.

				tons	*cwts.*	*lbs.*	
1st measurement—		1 acre	produced	11	17	56	of potatoes.
2d	plot	1 do	do	11	12	26	do

As soon as possible after the potatoes were harvested, the field was cleaned, plowed, and wheat drilled in, at the rate of 3 bushels per acre. As soon as the weather was suitable in the spring, the *whole* field got a dressing of 3 cwt. of Peruvian guano to the acre. During the winter very little difference was apparent ; but shortly after the application of the guano, the wheat on that

portion manured by the covered dung took a decided lead, which it retained all summer. The whole field was cut on the 26th of August, 1852 ; the portion manured by the uncovered dung being at least four days earlier than the other. As before, the two separate portions in each half of the field were measured, cut and stooked separately. On the 4th of September, each portion was thrashed, the grain carefully measured, and the straw weighed. On account of a wet season, the grain was of lighter weight than usual. The result of the experiment was as follows :—

Produce in Grain.			Weight per Bush.	Produce in Straw.	
acre.	bush.	lbs.	lbs.	stones.	lbs.
			With Uncovered Manure.		
1st	41	19	61¼	152 of	22
2d	42	38	do	160	do
			With Covered Manure,		
1st	55	5	61	220 of	22
2d	53	47	61	210	do

These and similar experiments have satisfied Lord KINNAIRD of the advantages to be derived from having farm-yard manures put under cover. They seem so conclusive and instructive on this point as to deserve to be brought before the farming classes of this country. It will require but a few minutes to determine the probable profits of protecting any certain amount of yard-manure. It appears from the above results that Lord KINNAIRD got about 125 bushels of wheat more, from the 10 acres manured with covered dung, than from the 10 acres which had been manured with the uncovered.

MANURING DISTANT FIELDS WITH BARN-YARD MANURE.

672. Fields that are at a considerable distance from the barn are liable to be cultivated without receiving as much manure as those near the barn ; because it is attended with so much expense to haul coarse manure a great distance, when the ground is soft. And sometimes it seems utterly impracticable to haul out any manure for a spring crop, on account of wet weather and wet ground. It injures most soils to drive over them very much

with teams and loaded vehicles when they are so saturated with water that the animals sink several inches deep; and clayey soils do not recover from such tramping and poaching in one season, unless they have been plowed in the fall and exposed to the rains and frosts of winter. Therefore a farmer must calculate to haul coarse manure to distant fields when the ground is hard, or in the winter on a sleigh, and put it in conical heaps; or to spread it as he draws it out; or to use guano, or some other manure, less bulky; or to plow under clover or Indian corn. If distant fields have an abundance of vegetable matter in the soil, it will be more advisable to apply guano, poudrette, dried blood, bone dust, &c., or some of each kind if they are not too expensive. When the soil is rather destitute of vegetable matter, however, before a farmer expends his cash for manure of any kind, unless it can be obtained at a very reasonable price, he should plow under clover or Indian corn. Some farmers contend that clover plowed under is the cheapest manure that can be made. It is a great fertilizer; but I believe that a soil can be renovated sooner, and at a less expense, with Indian corn than with clover; because a much larger quantity is turned under yearly of corn than of clover. By being expeditious in business when a crop of wheat, oats, or barley is taken off early in July, as they are many times, if the soil is plowed immediately and Indian corn sowed, it will grow large enough in ordinary seasons, before the autumnal frosts, to plow under. But when clover is raised, no other crop can be grown the same season.

GUANO—WHAT IT IS.

673. Guano has always been called the excrementitious matter of birds living in the islands of the sea and subsisting on fish. As there is seldom any rain on those islands to wash away the fecal matter, it has been accumulating for ages after ages, until it is of unknown depth in some places. The moisture in that just dropped soon disappears; and the whole shortly becomes a dry mass, not unlike dry hen manure. Vessels go to these islands on purpose for a load of guano. It is shoveled into wheel-

barrows and wheeled on board of ships; and thus becomes a very valuable commercial manure, when it is not adulterated by dealers.

674. The following brief account will be read with interest: "It is now 22 or 23 years since the first crop of guano was imported from the Chincha Islands, on the coast of Peru. These islands comprise three rocks, the joint area of which is under 3,000 statute acres; and the quantity of guano still upon the rocks is commonly estimated at 15 millions of tons, valued at more than 100 millions of money. The account of these islands is totally different from any I have ever yet seen published; for instead of the guano being exhausted in eight or ten years, which most writers assert, the supply, comparatively speaking, is inexhaustible; the beds of guano being in many places more than 100 feet thick, and two of the three principal islands being yet untouched. On climbing the cliffs an innumerable quantity of skeletons of large marine animals were presented to view, such as those of the seal and walrus, or sea-horse, striking up out of the surface in such quantities that the place appeared to be completely white all over. Passing along over the island we could scarcely take a step without our feet breaking through into a hole in which the guano bird makes its nest. These holes extend 5 or 6 yards into the bed of the guano; and the birds are continually occupied in fetching fish from the sea to feed their young ones. The number is so immense that the air seems completely alive with them. By this account it seems that guano is not all excrementitious matter, as we have hitherto been led to suppose; but consists of a considerable amount of decomposed animal matter in addition to the excrement of birds. It is evident from this sketch, that the supply of guano will be, at present, by no means limited."

MANNER OF APPLYING GUANO.

675. Guano is a fertilizer of great strength; and if allowed to come in close contact with the tender roots and germs of young plants, they cannot grow much better than they would in embers. The true way to apply it is, to sprinkle a handful over an area of at least eighteen inches in diameter, where the hills are to stand;

and after spreading on a thin stratum of dirt over the guano, drop the seed and cover it with mellow soil. By spreading the guano over such a large area, it will not injure the roots of young plants; and they will absorb the fertilizing matter that is dissolved by the rain more readily. When guano is correctly applied, there is no more danger in using it than there is in applying gypsum or lime. It is decidedly wrong to simply throw it down in a heap, thinking that it will promote the growth of a hill of corn when it is confined to such a limited area of ground. *The roots of Indian corn often spread two feet on each* side of the hill. Now, if a handful of fertilizer be spread on an area of six inches in diameter, are we to suppose that the limited amount of roots in that space will take up a large proportion of the available nourishment? Nothing is more palpably absurd.

676. The improper manner in which guano has frequently been applied to Indian corn and some other crops, has brought it into great disrepute as a fertilizer. Indeed, such have been its injurious effects on Indian corn, that it is no uncommon thing to hear it denounced as a very dangerous manure. And I must confess, considering the manner in which it has been applied, it is not at all strange that it should have worked such injury. But let it be applied as directed, and its good effects will be really surprising, if the guano has not been adulterated. If more than a small handful be applied to a hill, cover the seed about half deep enough; then sprinkle the guano over an area as large as above directed, with the seed near the centre, and cover it lightly. As much of the fertilizing matter in the guano is somewhat volatile, it should be covered with a thin stratum of earth as soon as applied to the hills. A thin stratum will absorb all the volatile matter, as well as if it were an inch or more deep, and the rain will carry it down to the roots. It is important to apply it so thin that the roots may spread laterally in every direction in the soil, and not be enveloped in guano so thickly that they cannot enter mellow earth without passing through the stimulating fertilizer.

APPLYING GUANO IN A LIQUID STATE.

677. The best and safest way of applying guano, or any other manure, in which there is such a great abundance of soluble fertilizing matter, is to put a few pounds in a large tub or barrel filled with water, where it can be allowed to soak for several days. During the time it should be stirred up occasionally. This liquid can be applied with a cup or dipper, sprinkling about one pint to a hill. Or it may be sprinkled around hills of corn, or anything else, with a water pot. It must not be applied to the leaves.

678. The great, practical question which every farmer desires to have answered is, will it pay to purchase guano, at sixty dollars per ton—the present price? It certainly will not, if guano is adulterated as some other commercial manures are. (Read par. 621.) As pure guano contains such a large quantity of plant-forming and grain-producing material, a few hundred pounds will manure a large breadth of ground. Four or five hundred pounds of unadulterated guano per acre will produce as good crops as twenty-five loads of ordinary barn-yard manure. When it has been greatly adulterated, *four or five tons are needed*. Every farmer can compute the cost of purchasing and applying five hundred pounds of guano to an acre of Indian corn, potatoes, or wheat. Good guano is an excellent manure for wheat, as it contains a large proportion of nitrogenous matter. It may be sowed broadcast with a machine or by hand, and harrowed in with the grain after the ground has been harrowed once to render it smooth. When the price of guano is not more than thirty dollars per ton, if a farmer has only a limited supply of barn-yard manure, it would, no doubt, pay to apply four or five hundred pounds to an acre, especially to fields at a long distance from the manure yard. It is difficult to determine when guano is adulterated. But growing crops cannot be deceived. If there are lumps, the whole should be reduced to a fine powder before it is sowed.

HEN MANURE AND ITS MANAGEMENT.

usually overlooked by most farmers. A very few understand that such fecal matter is often equal to the best Peruvian guano. Such men save and apply it to their soil. Others allow their fowls to roost on trees, fences, or any other places, where their droppings are wasted. Every farmer who keeps fowls should provide good places for them to roost. Then remove all coarse rubbish, and keep the floor beneath the roosts well littered with fine muck. This will mingle with half-fluid droppings, and render the mass less offensive to handle. Fine sawdust will increase its bulk and absorb ammonia. The very fact that hen manure when first dropped is so offensive shows that it is very valuable as a fertilizer.

680. In order to prepare it for use, spread it on a thin layer of muck on a barn floor; and then, with flails, or by running it through a threshing machine, reduce it to a fine condition. It may now be sowed broad-cast, or applied by hand to crops in drills or hills. I have known good farmers to practice this method, and have done it myself, with good results. The manure was applied to Indian corn at the time of planting. A good farmer writes: "I have a field of corn which grew very slowly, and the prospect for a crop was very discouraging. A neighbor offered me the droppings of his hen roost. His offer was gladly accepted; and two large wagon loads of manure was the result. This was liberally applied—a handful to a hill—as far as it would go. Two weeks after this application there was a great difference between the manured and unmanured portion; the manured part was much larger than the yellow, sick-looking, unmanured portion. At length many good farmers expressed great wonder at the vast difference between the two portions. The part manured yielded three times as much as the unmanured per acre, and of much superior quality."

MANURIAL VALUE OF DEAD ANIMALS.

681. Domestic animals will sicken and die sometimes even when they have the best of care. We always expect to make beef of old oxen and cows. Therefore we do not calculate on any

manure from their flesh. But, old horses must die. Young ones are not exempt from death. Mares, valuable cows, sows and ewes often die when in good condition. Their flesh is a nuisance if left unburied Some contend that a horse or cow is worth twenty dollars for manure. This is exceedingly doubtful. Still, such animals are worth saving, by working their flesh into compost; allowing the horse to weigh 1,000 pounds, and the muck and labor to be worth ten dollars, this would make the carcass worth ten dollars, at one cent a pound. It might not be advisable for a farmer to buy carcasses at this rate, while it would pay largely to save everything of the kind upon his farm or within his reach. It is not necessary to attain results entirely accurate to show the economy of saving all these wastes. The muck heap and composted, dead animals are a source of profit, and pay largely for the labor. We want the crows to prey on grubs and insects, and not on dead animals. We can put these to a better use. Every pound of flesh, rightly used, gives a peck of potatoes. Let them be saved. Place three or four loads of sods or muck in a convenient out-of-the-way place, yet within sight, so that dogs can be watched ; and if they manifest too great a regard for the old horse, a well-directed bullet may introduce them to a still closer companionship. Then the horse is taken upon the heap, killed, and the skin removed, which more than pays for the job. Without further ceremony, five or six cart-loads of muck and soil are thrown over the carcass, and it is left six months or a year, according to the season, a certain amount of warm weather being necessary, and it not being agreeable to overhaul the heap in the heat of summer. Then fork it over, throwing out the bones, which will then be well freed from flesh ; sprinkle over the heap a peck or two of plaster, and add perhaps a little fresh muck or soil upon the surface. Let it lie a month ; then fork it over again, and it is fit for use, an excellent manure—worth more than an equal bulk of good barn-yard manure. Spread it very thin, and harrow it in. Or it may be applied to corn or potatoes in the hill.

682. I am acquainted with a good farmer who pays ten dollars each for all the old horses he can purchase ; and composts

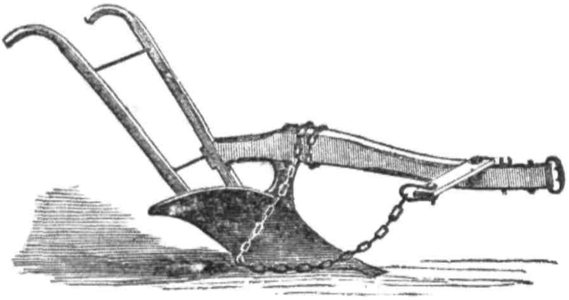
them ; and applies the material as a top-dressing for wheat. All the hard bones are crushed in a bone mill. By this excellent system of management of returning to the soil all the flesh-forming and bone-producing material that had been picked up by grazing animals, his soil is kept improving ; and he makes every branch of farming pay well.

PLOWING IN GREEN CROPS FOR MANURE.

683. One of the most economical ways of improving the fertility of an impoverished soil, or of renovating a barren one, is by plowing under some kind of green crop. Farmers have relied chiefly on red clover for this purpose, and there are thousands of acres of soil naturally unproductive that have been brought to an excellent state of fertility by applying gypsum to the clover crop and turning it under as green manure. Indian corn, buckwheat, and some other plants are employed for the same purpose, as are also marrowfat peas, sown thick in drills, between rows of early sweet corn, as soon as the corn is cultivated and hoed the last time. Then, as soon as the ears are gathered, every thing is turned under by plowing crosswise of the rows. In those districts where broom corn is raised, the portion that remains after the brush has been gathered, is usually plowed in to enrich the soil. The same thing is practiced, in some instances, by farmers on our Western prairies. Sometimes tall weeds take almost entire possession of a field, which, when they are plowed in, furnish much vegetable matter for improving the fertility of the soil.

684. The usual means employed for turning under such materials consist of a log chain or large tarred rope having one end attached to the outer end of the whiffletree of the offside horse, and the other end hitched around the beam of the plow, near the standard, as represented by the illustration herewith given. The chain should always be long enough to draw the tops of whatever is being plowed in along in the furrow, just in time to allow the furrow slice when turning to fall on it. If the chain is a few inches too long, the furrow slice will fall upon it and be broken and displaced as the chain draws out. Take a "rolling

hitch" around the beam of the plow, and then adjust the length of the chain until the bight of it will remain on the turning furrow slice only two or three inches forward of the point where it



ATTACHMENT FOR TURNING IN WEEDS.

comes to rest. This will draw the tops of weeds, grass, Canada thistles, and cornstalks completely beneath the falling earth: whereas without such a contrivance the tops would extend above ground, and if not already matured, would continue to grow sometimes quite as well as if they had not been plowed in. Sometimes weeds and cornstalks are first mowed close to the ground, and hauled into the furrows as the plowing is in progress. But in this practice the green material is not distributed as evenly as it is when plowed in without being mowed.

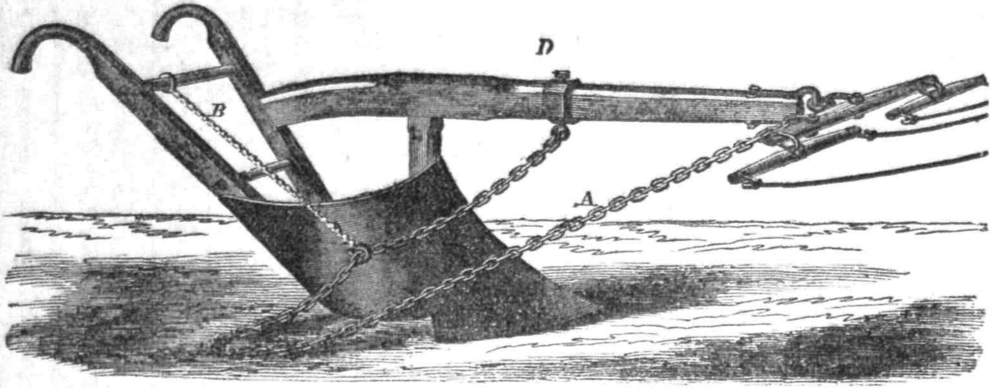
685. A piece of half-inch round iron, bent in the form of a letter U, is used instead of a chain for drawing under red clover or other crops. But as a chain is more flexible than an iron bow, it has been found more convenient. When the plow is drawn by oxen, the chain is attached to a stick about 20 inches long, bolted to the upper side of a beam, as shown by the preceding engraving. If hitched to the forward end of the plow beam, the chain will not always run far enough to the right side of the furrow to draw in the tops of all the stalks. However, if the chain is adjusted correctly as to length, the work can be performed quite satisfactorily.

686. Some plowmen have considered it essential to pass a heavy roller, and sometimes a harrow, over corn stalks and weeds. But we have always found it unnecessary, as the part of the team that travels on the unplowed ground will always tread it down as fast as it is plowed in ; and they will also bend it over in the right direction. We have plowed in green corn stalks, the average height of which was eight feet over the entire field, without using a roller or harrow to lay it down, as the nearside horse and whiffle trees broke it down in the most desirable manner.

KILMERS' IMPROVED ATTACHMENT.

687. Plowmen exp rience some difficulty in keep'ng the bight of the chain back in its proper place on the turning furrow slice. For this reason they are not able to draw every thing under the slices, as is desirable. To obviate this difficulty, J. & A. KILMER, Barnerville, Schoharie Co., N. Y., have recently invented and patented an improvement by which the drag chain is kept in the place desired.

688. The accompanying illustration will furnish a good idea of Messrs. KILMERS' chain, passing from the main chain to the plow-round or handle, which can be adjusted at pleasure. The engraving needs no further explanation. I saw it tested in plowing in weeds,and it operated in a most satisfactory manner. It is strange, indeed, that such a simple and good contrivance should not have been thought of before. The improvement can be attached to any plow. The device has just been secured by letters patent. Many old farmers have declared that they have used this contrivance for 25 years. Therefore they maintain that it is public property. Unless it can be shown that Messrs. Kilmer were not the inventors, and that they had seen or heard of it, the law would be on the side of the inventors. The safest way is not to use it ; or to pay a few dimes royalty to the patentees.



KILMERS' ATTACHMENT FOR PLOWING IN WEEDS AND GREEN CROPS.

A represents the main chain attached to the whiffletree. D, the place where it is fastened to the beam. B is the adjusting chain, for holding the bight of the main chain in the desired place on the furrow slice. In practice, the main chain must not be too long or too short. If too long, it will be difficult to keep the bight at the right place on the furrow slice. If too short, it will not gather all the weeds as nicely as if it were of the right length The plowman must exercise his own judgment as to its length.

FISH MANURE—FISH GUANO.

689. One of the means we have of getting back from the sea the fertility which flows on every hill-side and meadow, from every country ditch and city sewer, is to use the fish for manure. The time will never come when so little fish food will flow into the sea from our rivers and harbors, that fish will not multiply prodigiously along our coasts. Though it is true that in many parts of Europe, where there used to be good fishing in streams, the sportsmen complain that since the farmers have taken to thorough-draining, and scrupulously saving the wastes of the farm, the good fish have nearly, if not quite, all disappeared.

690. First among the fish used principally for manure in this country, is the *alosa menhaden*—commonly called Bony fish, Menhaden White fish, Moss Bunker. From time immemorial they have been taken in very large quantities along our coast, carted directly upon the fields, spread broadcast and plowed in, dropped in or on the hill for corn, composted in various ways, and subsequently applied in quantities of 7,000 to 15,000 to the acre. More recently the price of oil has made it profitable to take them for this product; and hundreds of factories have sprung up on the shore of New-Jersey, in many of the bays and inlets of the Sound, and further east. The fish decay very soon after coming from the water; hence these fish-oil establishments load the breeze with unpleasant odors.

691. A correspondent from Southold, L. I., communicates to the *American Agriculturist* the following facts on the subject of this industry. "Some eight or ten factories on the east end of Long Island work up yearly thirty and forty millions of these fish, which appear in the bays of the Sound generally from May until October. Caught with seines, they are brought to the factories, and generally thrown in large wooden tanks, from 8,000 to 12,000, according to size of tanks, heated by steam, though some parties cook in iron cylinders. When cooked, the water is drawn off; and the mass undergoes a powerful hydraulic pressure. After extracting all the oil possible, the residue is partly dried and run through a picker, a revolving cylinder with iron teeth cutting it

fine, then wheeled to a sheltered building in large heaps. Some years ago sulphuric acid was sprinkled over, but farmers objecting to it the practice was discontinued. Farmers speak highly of this fish fertilizer. The most valuable is turned over three or four times to evaporate the moisture, giving the buyer the most of the fertilizing substance ; it is used in drills for corn, or sown broadcast for wheat and oats. It looks but reasonable that this fish fertilizer should be very similar to Peruvian guano, the latter being the deposit of seabirds living mostly if not entirely on fish. The manure contains a great deal of phosphate of lime and much ammonia, either ready formed or remaining in the meaty part.

692. It is a query whether fish are turned to their greatest possible account as manure. It would seem that by good management they might be made to fertilize a large part of the barren sands which line the sea-shore. And what more just than that the sea should render back some of the fertility which has been washed into it from the land. Prof. JOHNSON happily remarks, "Guano is an indirect contribution of the ocean to Agriculture. The sea-fowl manufacture it from the fish with which the sea is everywhere teeming." Analysis shows that fish abound in nitrogenous and phosphatic elements ; and experience shows that they are very useful in bringing up lands otherwise quite unfertile. Indeed, we have known farmers to cart them fifteen or twenty miles distant from tide water, and to find the labor remunerative. Yet the slovenly practice of spreading fish on the surface of land, or imperfectly covering it for the benefit of growing crops, is one to be condemned. It is wasteful, and exceedingly offensive, if not unhealthy, to all the region filled with the foul effluvia. We would advise seaboard farmers to use all the fish they can get, in their own way. They can profitably be laid up with muck in heaps, to decay. A barrel of fish composted with muck or loam will make a rich dressing for any crop. For Indian corn and potatoes, plow them in, or apply them to the hill. American farmers must economize with reference to labor in handling manure. Fish will produce just as good an effect on a crop if

buried in the soil, and allowed to decompose there, as the same amount will produce it composted. In the first instance, the soil holds all the fertilizing matter; in the second, it is retained in compost muck. In either case, growing plants will find it. Still, where a farmer has muck, and his soil is very porous, with but little clay or mould in it, to retain fertilizing matter from decomposed fish, it might be more economical to compost them previous to applying the material to the soil.

KING-CRAB OR SPIDER.

693. In some localities on the sea coast the Horse-foot, King-crab, and Sea-spider—the *polyphemus occidentalis* of the naturalists—is common on all our Atlantic coast; but it seems to find a particularly congenial location in the lower part of the Delaware Bay. It comes to the shore to deposit its eggs in the sand in the early part of summer; the largest number, it is said, in the old of the moon in June, though they are abundant for several weeks before and after that time. They come in such numbers that the beach is literally covered with them for nearly forty miles up the bay-shore, from Town Bank, in Cape May County. They weigh, on the average, about four pounds each; and at a very moderate calculation, a million of them could be picked up on a mile of beach in one season. They are used in great numbers as feed for hogs; and their eggs are shovelled up in wagon-loads and carried off to feed chickens. Many of the Cape May farmers have thrown them up in piles and composted them with earth, as a manure for wheat; and the effects they produce are remarkable. The poorest soils that can be found, by a dressing of from 2,000 to 4,000 on an acre, it is said, will produce twenty or twenty-five bushels of wheat; and thirty bushels is not an uncommon crop. This testimony in regard to their fertilizing action is confirmed by the experience of a number of farmers of whom I have inquired; and yet there is a singular prejudice against them. It is said that corn or clover will not thrive on the soil where they have been used; and that they bring on sorrel. This latter fact has been mentioned by several; but I am inclined to think it a difficulty

of but little moment. Indeed, I can perceive no reason at all for *such effects following the application of such fertilizers.* And I do not believe it. I believe the more of such material one can apply to his soil the better.

HORN PITHS—HOW TO USE THEM.

694. In many places, horn-piths can be had at the tanneries by cartloads; and in those sections of the country where there are no mills for crushing bones, they are not considered of much value. But, "pound for pound," they are worth as much as large solid bones; because the piths, from their more open, porous structure, decompose much sooner in the soil than the more flinty solid bones of animals; and consequently are more readily available as a manure. We know a farmer who has used several cartloads of horn-piths the two past seasons for manuring his potatoes in the hill—a pith in each hill at the time of planting—more than doubling the crop over those rows having no manure. As the potatoes are dug, the piths are thrown into heaps, and afterwards carted off and deposited in a safe place for the next year's use. They will last for this purpose many years. The farmer pays about one dollar and fifty cents a cartload. He also occasionally obtains from the same yard the lime, after having being used for starting the hair on the hides and skins, as well also as some of the fleshings and poor quality of hair. These are made into compost by mixing with loam or muck; and make a good and lasting manure; and at a much cheaper rate than he could procure stable manure. Horn-piths may be ground as bones are, and applied in the same way.

WASTE OF WOOLEN MILLS.

695. The waste wool from woolen factories and carding machines can be some times had at a trifling cost. Wool and woolen rags contain a large per cent. of nitrogen, and about five per cent. of sulphur. One hundred pounds of wool contain about seventeen pounds of nitrogen—as much as there is in the very best guano, and more than there is in thirty hundred pounds of

fresh cow dung. Wool and woolen rags decompose very slowly in wet, stiff soils. Therefore, if used in their natural state, they should be spread upon sandy, or light, warm, loamy land, and plowed in. On such land they are valuable and lasting manures. Great quantities of waste wool and woolen rags are used to manure the hop grounds in England; and the hop-growers there readily pay from twenty five to fifty dollars per ton for them as manure for their hop grounds. From the slow decay of wool and rags, they probably can be most economically employed when previously rotted, by being made into a compost, and then applied to the wheat crop. I am not prepared to say exactly what our farmers could afford to pay per pound or ton for waste wool and rags. As far as nitrogen is valuable in guano or other manure, wool is one of the most valuable; and the farmer perhaps would not be running a great risk in paying one cent. per pound for waste woolen rags.

696. I am acquainted with a large farmer who purchases thousands of bushels of such material at fifty cents per load of about fifty bushels, and hauls it over two miles. It is usually spread in his stables and yards, where it becomes thoroughly mingled with barn-yard and stable manure. It produces large crops of wheat, or any other grain.

HOW TO USE LEATHER SCRAP.

697. They make an excellent road and sidewalks about the village; and after they are well trodden down and have been rained on a few times, they make a soft, dry, elastic walk, free from dust and mud. Then, too, they make excellent fuel, provided there is a strong draft in the chimney. These are common ways of disposing of this article. As fuel, its worth is estimated by some shoemakers and leatherworkers as nearly or quite equal to anthracite coal, ton for ton. The only trouble is it decomposes very slowly. Dry skins, before they are tanned; contain about eighteen per cent. of nitrogen, which, if it could be made available to plants in the form of ammonia (which is not difficult), would make the value of raw hide scraps about twenty dollars per ton. In the

process of tanning, many changes take place in the hide. Some lime becomes incorporated with it, and a large amount of tanning is absorbed.

698. The editor of the *Genesee Farmer* writes: "The largest crop of potatoes we ever saw raised was upon land which had received a liberal dressing of old, well rotted manure belonging to a saddler who kept a horse and cow, and who was in the habit of throwing all his old scraps of leather on the manure heap; and proceeds to quote from a correspondent, who says that he offered the boys in his town twenty-five cents a cwt. for all the old shoes they could collect. "He procured in this way several hundred pounds, roasted them in an oven heated to double the heat required to bake bread; and they became sufficiently brittle to be readily ground in a bone mill. The leather dust was put on potatoes in the row, along side of bone-dust; and the difference was in favor of the leather manure, it being much finer, and consequently having more immediate effect; the usefulness of bones, however, was also distinctly seen from a distance. On each side a liberal supply of barn-yard manure was used; but the difference was very plainly shown in favor of the former two fertilizers. The ground was put in with wheat after the potato crop was taken up; and now no difference can be seen between the leather and bone manure; but a very marked difference, at a distance, where those fertilizers and the barn-yard manure were applied—the former leaving a dark green streak through the field, with tall and well-stocked grain.

699. The most economical way for farmers to dispose of leather scraps and hide shavings is to haul them directly to the field and harrow or plow them in. This saves labor; and growing crops will find the nourishment afforded by such substances. Perhaps three or four years after they have been spread on a field, the good effects will appear. Let such material be applied to any kind of soil; and spread very thin. They are more valuable on heavy than on light soils.

VALUE AND USE OF CHARCOAL.

700. The virtue of charcoal mainly consists in its absorbing power. The purity of the air around a charcoal pit has long been known; and the colliers notwithstanding their smutty appearance, are robust men. The secret of this purity of the air and the health of the colliers lies in the fact that charcoal absorbs from the air the ammonia and other noxious gases unsuited for our lungs, but just the food for plants. Every good housekeeper knows that if her boiling meat gives forth an unsavory odor, a piece of fresh charcoal put into the pot will not only sweeten the air, but will remedy the taint of the meat. In the same manner it acts when applied to the land. It absorbs from the air those gases offensive to our nostrils, but the main food of plants. Where an old coal-pit has been burned, the land never seems to wear out; and the first settlers point to the coal bottoms that are fifty years old, still by their exuberant vegetation marking well the spot where the wood was converted into coal. A fertilizer so lasting is well worth some expense at the outset. But where can we get it, some may ask. If any charcoal pits are burned in your vicinity, the bottoms will furnish three or four loads of refuse charcoal mingled with burnt soil. The latter is highly valued also as an absorbent. Around furnaces and blacksmith shops the waste charcoal also accumulates, and in many instances may be had for the carting. It may be found also around engine houses, thrown out from locomotives. If none of these resources are at hand, then use the best substitute possible, which is muck or swamp mud; and double the manure heap by composting; and if the crops are not doubled, then my experience is vain.

701. A correspondent writes: "For two years past I have used some fifty loads each season of refuse charcoal, and being fully convinced that it pays, I wish to recommend it to my brother farmers. I have tried it on grass, corn and potatoes—have tried it alone, and in the compost heap, and in all situations it has proved faithful to its trust. As a top-dressing for grass, it gives a green color and luxuriant growth. Applied to half an acre of

early potatoes the last summer, the yield was seventy-five bushels of as fine healthy potatoes as could be desired, that sold readily for one dollar per bushel, and yielded the best profit of anything raised on the farm."

702. Finely pulverized charcoal is an excellent fertilizer for grass, grain, vegetables and fruit trees. If it is coarse, it will pay to run it through a corn mill, to reduce it as fine as possible. Let it be sowed or spread on land, the more abundant the better. Charcoal dust ought *not* to be mixed with manure, in the hog-pen, in the privy or anywhere. If the substance be mixed first with charcoal, and then covered with soil or muck, little loss will take place, and the coal will be a real benefit. Mechanically and chemically, charcoal is often of great benefit to the soil.

BITTERNS—REFUSE OF SALT WATER.

703. Chemists inform us that the *bitterns*, as they are called, which constitute the sediment taken from the boiling brine, consist essentially of plaster. The scale which forms in the kettles, called *blocking*, and which is taken out when they are cooled down, is a mixture of plaster and salt, varying in the proportions of the ingredients with the thickness of the scale—the thickest being nearly all salt, and the thinnest containing forty or fifty per cent. of plaster. The sediment taken from the *lime-rooms*, in the solar fields, is plaster. The most valuable manure about the salt works is the wood ashes. There are perhaps 200,000 cords of wood consumed annually in making salt at Salina, Syracuse, Liverpool, and Geddes. These ashes usually have some salt mixed with them, which spoils them for making potashes, but does not diminish their value for manure. They are perquisites of the salt-boilers, and are sold at a nominal price. Some farmers think them valuable as a fertilizer. Others esteem them worthless. The true way to use them is to try an experiment with them on a small scale. This will satisfy any one as to their value.

VALUE OF SAWDUST—HOW USED.

704. In some parts of the country, immense quantities of sawdust, turning and planing shavings, may be collected in warm

weather for littering stables. When dry, it will absorb and retain much liquid manure; and as soon as it is plowed under or spread on the surface it decays quickly, and the roots of plants take care of the fertilizing material contained in it. I have known farmers haul saw dust and planing-mill shaving two miles, to be used as absorbents in the stable; and the manure thus made produced excellent results. H. LEWIS, of Frankfort, N. Y., stated that "he had twenty-five acres of meadow that would yield annually a quantity of hay sufficient for the winter keep of fifty head of cattle. Some of his grass had already lodged early in the season, and he thought would not come up again. He should commence his hay harvest in about three weeks. This extraordinary fertility of soil and growth of grass had been effected by under draining and top-dressing the soil with sawdust, in which was absorbed the liquid manure from his stock. He regarded the liquid manure of more value than the solid excrements of the animal. The conclusion had been arrived at by experiments, and from observation. Stakes had been set in pastures and meadows to note the effects of liquid and solid manures, and the growth of grass was in favor of those spots where the animals left liquid manures. Some few years since he commenced using sawdust for the absorption of liquid manures and spreading the compost on his grass lands, the soil responding in a most remarkable manner. Latterly he had been using the dust at the rate of sixty bushels per week. The manure is hauled upon the land and spread as evenly as possible with a shovel or fork; it is then brushed and completely broken up, and distributed in fine particles. This division and fineness of manure is regarded of peculiar advantage, since the plants are better able to appropriate their food, and it reaches a great number. About half of the meadow is underdrained with horse-shoe tile, the drains being sunk three and a half feet deep. On this portion of the meadow grows the largest grass."

VALUE OF SOOT.

705. This, though generally thrown into the street and wasted, is one of the best manures. It is extensively used in England, and

when only fifteen or twenty bushels are applied to the acre, induces the most luxuriant crops of wheat and other grains. It contains, in small compass, almost all the ingredients of the coal or wood used for fuel. It also contains several salts of ammonia, magnesia, and muriatic acid. Its components are the natural food or stimulants of plants, and it can be used to great advantage as a concentrated fertilizer, to stimulate germinating seeds in the drill. It is not only sown broadcast with the grain, but it is applied to the root crops with the best results. Potatoes and carrots especially are benefitted by it. Six quarts of soot to a hogshead of water make an excellent liquid manure for the garden. It can be applied with safety to all garden crops, and will pay for saving. In putting the stoves, furnaces, and fireplaces in order for winter, bear it in mind that soot is valuable, and will be wanted for spring use. One, two, three or more barrels can be saved, in most families, especially where wood is burned. Instead of allowing large chimnies to burn out, thus endangering the dwelling, remove the soot with a long-handled scraper.

BENEFICIAL EFFECT OF FERTILIZERS.

706. The *New England Farmer* says on this subject: "Fertilizers have a two-fold effect: nutritious effect on plants; and the effect of modifying the soil. Certain substances are essential to the growth of plants, which the manures must furnish, if the soil is deficient in them. And these are all the ingredients of plants, except silica and soda. Soil, however, is seldom deficient in certain other substances, as iron, chlorine, magnesia, lime. Whatever nutritious element of soil is deficient, becomes most important in fertilizing. The absence of any one essential ingredient renders the presence of all the others of no account. Manure may act directly or indirectly, in the process of feeding plants. The elements of manure may be taken up at once by the plant, and may act precisely as the elements of the soil which are available to feed the plant. If we take a barren soil, in which a plant will reach a small growth, the addition of bone ashes or the ashes of wood will make the development of vegetation luxuriant;

and if the quantity of these fertilizing materials is properly chosen, we may prove by analysis of the plant that it has absorbed these matters almost completely from the soil. This shows that under such circumstances the fertilizing matter passes at once into the plant.

707. Then there are manures operating indirectly by acting on the soil; not on the plant immediately. The application of lime, in large doses, to the soils already charged with lime is beneficial in this way; by acting on the soil it liberates matter already existing there, but in an insoluble state. It would liberate the alkalies, like potash; and if long manured with animal manures, it will liberate the inert nitrogen. Lime often has the same effect as guano, by liberating potash, as the solution of guano in the soil does. The action of plaster and common salt is undoubtedly owing to this indirect effect we speak of—the preparation of the soil for nutrition. Recent experiments have demonstrated that a solution of plaster liberates from many soils potash and magnesia. It has been found by comparing the effect of pure water and a solution of plaster on soils benefitted or not by plaster, that in the former case potash and magnesia are liberated in considerable quantities; in the latter not at all. Certain minerals which contain silica, alumina, &c., analogous to the composition of soil, and which being formed under conditions analogous to the composition of the soil may be supposed to exist in the soil, when subjected to the action of saline solution undergo chemical changes which throw some light on this indirect action of fertilizers. Minerals of this kind containing lime, subjected to a solution of common salt, will part with the lime, and hold the soda and salt in fixed combination.

708. This new compound, treated with a solution of potash, will lose a portion of its soda and acquire potash. A solution of magnesia will displace the potash again. And, in general, the effect of any one alkali in solution will be to displace a quantity of some other held in the combination. Manures exert a *physical* effect on the soil. Peat or vegetable matter will often act favorably on soil by altering the texture. The extremes of dryness or

wetness in light or heavy lands are brought by it to a proper medium, although this is not its only action.

709. The effect of lime on clay is physical to a great degree, as was found by the Lusatian farmers in liming their clay lands to bring them into tillable condition. They found that under-draining produced the same effect. Lime is found, when mixed with moist clay, to increase its bulk and change its texture. Nearly all fertilizers, when applied in large quantities, as stable manure, ashes, &c., produce greater or less alterations in the texture of soil which are advantageous. These three modes of action are all dependent one on another, and each fertilizer exerts them all to a greater or less degree. It may happen that many fertilizers which act chiefly to supply food to the plant, in other cases may act by improving the texture of the soil. On many rich soils stable manure does more good by the physical action of the litter than it does by the fertilizing materials which it adds.

710. The action of manures is influenced by the peculiarities of the soil. Some soils are benefitted by plaster and salt, while others are indifferent to these fertilizers. It is probable that the testimony of practical men, asserting that some soils are damaged by these fertilizers, is correct. If plaster acts by liberating potash, its effect would not be manifest on a soil furnishing an abundance of potash to the crops, and large doses of plaster, by increasing the solubility, already sufficient, might waste the resources of the soil.

711. Soils undergo modifications from year to year by tillage, cropping, &c., and thus become subject to new requirements. We often find a course of manuring which has been efficacious for years lose its value and efficacy, and other fertilizers that had been in disrepute are found to be advantageous. On the shores of Long Island Sound fish have long been employed, and have at last proved to have lost their beneficial effects; and on such lands super-phosphate of lime has operated with good effect.

712. Generally such partial fertilizers as fish, guano, lime and plaster are liable to fail after many years, and something else is necessary. Peculiarities of the plant also influence the action of

fertilizers. Much experience seems to prove that turnips are specially fond of super-phosphates. Clover grows readily after an application of ashes or plaster, a fact accounted for, perhaps, by the supply of potash which they give.

HOW BARREN SOILS HAVE BEEN RENOVATED IN NEW HAMPSHIRE.

713. J. W. Proctor, in an address, alludes to the renovation of a barren farm that had for a long period been considered hardly worth cultivation, an extract from which will, no doubt, encourage many disheartened farmers to make and apply more manure to their poor fields. He writes: "Within the last ten years I have watched with much interest the growing of this crop, (rye) on the town farm in Danvers, where it has varied from thirty to forty-five bushels to the acre ; at no time less than thirty. This too, on a sterile soil, composed chiefly of yellow dirt and gravel stones, with as little capacity to retain the manure applied as a sieve has to hold water. Do you ask how these crops have been raised? My answer is, by thorough culture and manure. At each and all the plowings the plow has been sunk as deep as it could conveniently be drawn by two pairs of full grown and full fed oxen, (none others being thought fit to be used on a farm where cattle are *bought*, not *reared*,) and the manure applied has thus been thoroughly mingled with the soil. Upon a stratum thus prepared the crop has started and been supported, and seldom impaired by drouth—the greatest obstacle to be encountered on any soil. On this farm, containing about sixty acres of land under cultivation, exclusive of wet meadows and wood-land, there are annually made two hundred cords, or five hundred loads of manure, chiefly from material taken from the peat meadows, and from the offal collected from the slaughter-houses of the village, by the aid of sixty swine, constantly kept, and changed twice a year. Thus the natural sterility of the land is in a good measure corrected, and at a moderate expenditure, crops rivalling those on our best farms are produced. It is within my recollection when it was seriously contemplated to abandon this farm, as not being worth purposes of cultivation."

IMPROVEMENT OF COLD SOIL IN MANURE.

714. A correspondent of the *Maine Farmer* gives an account of the manner in which a neighbor of his brought a lot of three acres into profitable cultivation. He says: "Said land was mostly a cold, clay soil, partly covered with alders; one end of the lot stony—so poor that the former owner said it would not produce weeds. His first operation was to cut drains sixteen to twenty feet apart, three feet deep, and two and a half wide at the top. These were filled with small stones from the stony portion—next plowed—(in the fall) ten inches deep. Next spring hauled about ten cords green manure on one acre; plowed again shoal; harrowed in a part of the dressing, (which he thinks preferable to plowing in,) then furrowed and manured in the hill with a shovelful of old yard manure, and then threw a spoonful of phosphate lime on the top. Planted with corn on the 1st of June. The clayey soil baked so hard after a rain followed by drouth as to prevent the corn from coming up readily; so he went over it with an iron rake, breaking the *crust* over each hill. Now for the result: he harvested a crop from one acre, which, on being measured, and having the cubical contents reduced to bushels, was allowed to be one hundred bushels of bright corn, and this too in the cold Schoodic county, where there was frost every summer month. In addition to this large crop, he raised on the remaining land one hundred bushels potatoes, over two hundred bushels of turnips, four bushels peas, twelve bushels beans, and a quantity of pumpkins, beets and cabbage.

715. Another writer says: "Within the present month we have walked over fields which a few years ago were exhausted in the ordinary sense to the last degree—that is, they gave no crops of anything. Left to themselves they had had no sod, and the only vegetation on them was a sparse covering of weeds. Some of the adjoining fields more exposed to winds are to-day blowing sands. These fields are now well sodded, and have yielded the present season a good burden of grass. Three years is sufficient to renovate them. The first year one bushel of gypsum, and

nothing else was applied per acre. This simple application started clover; cattle were allowed to eat it off. The next year the same dose was given, and the animals were up to their bellies in feed. Now this sod being broken up, corn, wheat or rye will give a fair crop. With a little good manure, large yields may be obtained, and under proper management there is no end to this increased fertility." I have quoted the foregoing extracts to encourage the doubting to make and apply more manure.

THE PHILOSOPHY OF MANURING IN AUTUMN.

716. The philosophy of applying manure as a top-dressing in late autumn may be thus explained. The growing year is over. Everything is tending back to the ground from whence it came. Earth is to be resolved back to its mother dust. Grass, leaves, stubble, and all other vegetable substances, decay and go downward into the soil, where their substance will form new plants the next season. The temperature of the weather grows cooler and cooler almost every day; and the various gases in the soil do not rise to promote vegetation as they do in the spring of the year. Therefore when manure is applied in late autumn, almost the entire strength is carried down into the soil, and there retained as food for plants until the next spring, when new life of plants begins, and long and warm days increase the temperature of the soil; and thus those manurial substances—grass and salts—which promote the growth of plants, are brought up, and taken up by the roots of whatever is allowed to grow upon the soil. But when manure is spread on the surface in the spring of the year, only a small proportion of the salts and gases of the manure ever enter the soil; but are swept away upon every breeze, and almost wholly lost in their efficacy of the crops on him who claims those substances as his own.

717. I have observed, for many years past, that they who spread their manure on the surface in the spring of the year, promote the growth of their neighbors' grass about as much as they do their own; while, on the contrary, those farmers who spread it in the fall, derive all the benefit that the manure can impart in

heavier and better crops the next season. A thin sprinkling of the scrapings of the barn-yard and sheds applied in November to grass land, will often increase the crop more than twice the usual amount. This I have often tested, and have never known it to fail. On the contrary, I have never been able to perceive but little benefit from manuring grass land in spring. I have my mind on the meadow of a neighbor, to which there was applied a heavy dressing of good manure in April; and I watched it until the grass was mowed; and I am compelled to acknowledge that I could perceive little or no benefit at all arising from the top-dressing. The grass was very light, and yielded, as I judged, not more than one and a half tons of hay per acre. Had that quantity of manure been applied in autumn, no doubt the grass would have yielded more than three tons per acre.

LIQUID MANURE, AND PUMP FOR USING IT.

718. Although a large per centage of liquid manure is water, it is yet very valuable for promoting the growth of all kinds of crops, and often more so than the solid portions. Of course its value diminishes in proportion as it is diluted with water. When animals are fed on grain, the liquid which leaches from their droppings or is collected beneath the stables abounds in more fertilizing matter than that which flows from a pile of strawy manure. In the Old World the liquid manure of animals is saved with far more care than in America; and it has been stated by reliable authority, that in Belgium liquid manure is valued so highly, that the urine of a single cow commands over eight dollars per annum. Parties purchase it expressly for increasing the productiveness of their soils. If it is so valuable in other parts of the world, it certainly is worth saving in America. The great difficulty in collecting liquid manure is a suitable pump. There is usually more or less sediment among it, which would clog an ordinary water pump. We give herewith an illustration of a portion of a very cheap liquid manure pump, which we have found to be very convenient and effective. Any one who can joint a board straight and square will be able to make one with

little or no difficulty. Four pieces of thick board are required, from six to ten feet long. Two of them must be just four inches wide, and two others six inches wide. The latter two are nailed firmly on the edges of the others. This will make a penstock whose hollow is four inches square from end to end. Now fit a block in the lower end, and bore a two-inch hole through it, and fasten a valve over the hole to open upwards, and nail the block in place. The larger the hole the better, if the valve closes it well. The next thing is to make the piston, which is represented by the accompanying illustration, fig. 1. This should be of hard wood, three and three-quarter inches wide, and one inch thick at the lower end, fitting well but working easily. This will allow a piece of leather one-eighth of an inch thick to be nailed on each edge of the piston rod. Procure two pieces of leather, of the form shown in fig. 2, eight inches long from *F* to *e*, six inches broad at *F*, and five inches wide at *e*. These two pieces are shown nailed to the piston rod, fig. 1, *c*, *c*. At *A*, the rod is shown in two pieces, to indicate an indefinite length. *B*, is the handle to pump with. After the narrow ends of the leather have been nailed securely to the lower end of the rod A, place the edges of the leather, together, on the edge of the piston rod, and nail them firmly with lath nails. As the piston is thrust downward, the leather will fold together, as represented by the angular lines, *c*, *c*, and allow the liquid to rise above it. But as soon as the piston rod is lifted, the leather spreads out to the sides and corners, and raises all the liquid above it, and the liquid rushes through the valve in the lower end of the penstock, following the piston upwards. A spout can be made near to the

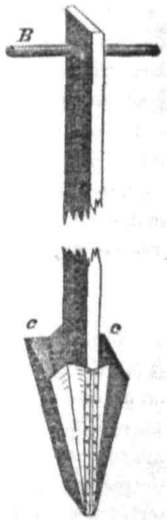


FIG. 1.

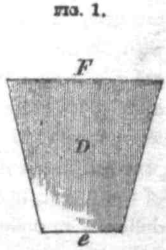


FIG. 2.

top to conduct the liquid where it is desired. Pieces of cobs, blocks of wood or chaff, will not obstruct the free working of this kind of pump. Such a pump will be found useful for pumping sediment from cesspools, or for emptying the vaults of privies, where most of the fecal matter is in a fluid and semi-fluid state. Paper will not obstruct the valve or piston. Such a pump will draw water out of a shallow well very fast. The deeper the well, the more power will be required to work it. (See pars. 498, 500.)

THE LAST WORD ABOUT MANURE.

719. I have spun out this chapter much against my own inclinations. But I know well what is lacking in American agriculture. It is manure—*manure*, and fertilizers. American farmers need line upon line about manure. They waste too much. They need exhorting, entreating, and beseeching to save with care, and apply more manure. Good cultivation and abundant manuring are the crowning concomitants in American agriculture. Farming cannot be made to pay for any considerable length of time without manure. On many kinds of soil it is folly to attempt to raise any kind of crops without a good dressing of manure. The sooner American farmers learn that by means of fertilizers only they are to make farming pay, the sooner our agriculture will be of a progressive and paying character.

CHAPTER V.

NOXIOUS PLANTS AND THEIR ERADICATION.

"Now rid your fields of one year's seeding,
And save the toil of seven years' weeding."

720. That farmer has a task before him, by no means pleasant, on whose fields noxious weeds have been allowed to go to seed for a number of seasons, or even for one season. Seeds of almost all kinds of noxious weeds will remain in the soil for many years—no one is able to determine how long—and not lose their vitality. Noxious weeds, of several different kinds, have vegetated in places on my farm which we knew had lain in the soil for more than thirty years. Before such seeds will vegetate they must be brought nearly to the surface of the ground. From what I have experienced in eradicating field mustard, winter cress, mulleins, and some other noxious weeds, I have no hesitancy in saying, that the seeds of such plants will not lose their vitality for centuries when buried in the soil. If they will vegetate after having lain in the soil for thirty years, as I know they will, they will not, probably, lose their vitality in one hundred, or five hundred years. Farmers should be exceedingly careful to allow no noxious weeds to go to seed where it can possibly be avoided When a crop of grain is harvested, with noxious weeds among it, never allow any of the seeds to find their way to the manure heap when it can be prevented. Fanning mills are made so perfect, at the present day, that there is no excuse for saving foul seed, with any crop, with the exception of grass seeds. While a farmer is careful to manure his soil highly and cultivate

it well, he must not neglect the complete extermination of pestiferous plants that are ever ready to choke his crops. High manuring and good cultivation are the first important steps towards the complete extermination of any plant. Better to abandon the cultivation of half one's farm, than to allow weeds to grow with crops, maturing their seed, and scattering it again in the field or at the barn.

721. The first step towards the complete eradication of weeds is to prevent their seeding, or at least casting any seed on the ground. If every weed is cut down before the seed is formed, an excellent beginning will have been made in a good direction. The next thing is an understanding of the *habit* of the plants to eradicate; otherwise all efforts will be unavailing. A farmer should know whether a plant be an *annual, biennial*, or *perennial.* Plants of different habit require very different treatment in eradicating them. Annual plants need a different system of management from perennials or biennials.

THE CANADA THISTLE—(*Cirsium Arvense.*)

722. The Canada Thistle, a cut of which is herewith given, is a *perennial* plant. It is propagated by seed and by its roots. The seeds are attached to a downy pappus, not unlike the common thistle or milkweed, by which they are scattered—there is no telling how far. When they are flying in the air, if they come in contact with the tops of forest trees they fall to the ground, and as soon as the timber is cut off, they will vegetate. The seeds will vegetate, if in a favorable place, any time from early in the spring to late in the autumn. If they vegetate in the former part of the season, they will not produce seed during that season, but will throw out lateral roots in every direction, and will send up a plant every few inches, and so near each other that in rich soils the leaves will cover the whole ground. In mellow soils and in wet seasons they spread very rapidly, and will soon take

possession of a whole field. But instead of being a *curse* to farmers, Canada thistles are a rich blessing in disguise. They have been the cause of raising very many noble crops of all kinds

THE CANADA THISTLE.

of grain; and they are a great source of wealth to slack, thriftless farmers; because had it not been for the thistles, such farm-

ers would not half cultivate their soil; and consequently not half a crop would have been produced. Canada thistles flourish best in a very rich, friable soil, although they will grow on almost any soil, if it is not too wet. It is far more difficult to eradicate them from a poor, worn-out soil than from a very rich soil. If a farmer cultivates and manures his soil well, raising those crops which will return him the most profit, Canada thistles will soon be among the rare specimens of exotics.

723. The roots of the Canada thistle strike very deep, and are exceedingly tenacious of life. There was a small patch where I once dug the cellar for a house, and although the subsoil, clear to the bottom of the cellar, was most complete *hard pan*, the roots extended below the bottom, and thistles sprang from them all over the cellar the next season after the house was erected. Canada thistles exhaust a soil but very little when compared with other plants; and if a farmer pursues the most proper course in exterminating them, they may be eradicated most effectively, with little labor, in one season. But if the labor expended in endeavoring to eradicate them is not applied at the proper season, according to a certain stage in the growth of the plant, they may be plowed and hoed through the entire season, and the next season they will appear as numerous and healthy as if they had not been molested.

724. Although they may be smothered in one season with any substance, or be completely eradicated with a hoe, or by pulling them, still, when they have taken complete possession of a field, the labor of extermination must be performed with the plow. Three times plowing on a rich soil will most effectively eradicate them, providing the plowing is performed at a certain stage in the growth of the plants, and the soil all plowed up with narrow furrows and no balks made. The reason why so many fail in their efforts to eradicate noxious weeds by plowing is, the plowing is only half done. A poor team, a poor, disinterested, unskillful plowman, with a poor plow and dull point, will scarify the soil just enough to make the thistles grow well

the next season. I have known instances where farmers commenced plowing thistles early in the spring, and kept them well plowed—four or five times—all the season, when on the next season a few thistles appeared ; and on the second and third seasons they were as numerous as ever. And I have known farmers delay plowing them until they were in blossom, when they would plow them three times, and destroy completely every root in the soil, but the next year they would appear from the subsoil as numerous as ever.

725. From these facts we learn that, in order to eradicate them thoroughly in one season by plowing, they must be plowed at a certain stage in the growth of the plant ; and the times of plowing must not be too far apart, nor succeed each other too soon. They must be "grown to death." If they are plowed in spring or summer, before they have attained a good growth, we may abandon the idea of eradicating them during that season. If the soil where they are growing is a sod, let it be plowed in autumn. On the next season, when the thistles begin to head, if they are so large that a team does not like to travel among them, mow them and plow the ground thoroughly. Let no balks be made. If they are not very large, they need not be mowed, but the tops may be drawn under with a chain. (See How to Do it, par. 684.) The tops of thistles will not turn to roots, as many people have stated, unless a portion of the top is left unburied. See that the tops are completely covered with earth, not less than two inches deep, otherwise they will continue to grow. After plowing, harrow, with a heavy harrow or cultivator, in order to draw out as many roots as possible. In not less than four weeks plow again, and then again in about five or six weeks. The thistles should have sufficient time to grow, to exhaust the roots; and they should not be allowed to grow so long between the plowings, that the roots will begin to spread or to acquire any strength. If the plowings are properly done, four plowings, at proper intervals, will eradicate any patch of Canada thistles. But if the soil is stony, and many balks are made, they will not all be eradicated in one season.

726. If there are but few thistles in a field, plant some hoed crop, and manure highly; and cut *every thistle* with a broad hoe, or pull them once in four or five weeks; and if the work is thoroughly done, none will appear the next season. But if some of them are left uncut, and some are bent down and bruised a little, there will be lots of them the next year. Pulling them is more effectual than hoeing, *if every one of them is pulled.* Let a few only be left, and you will always have thistles. In pastures, let them be mowed close to the ground as soon as they are large enough. One mowing in the former part of the season will subdue them more than two mowings after they have blossomed. If they are allowed to grow unmolested until they blossom before they are mowed, as a general rule it will not subdue them enough to pay for mowing, although I have known instances, on very rich soil, when thistles were four, and even five feet high, with large hollow stems, where they were mowed before a heavy shower, so that the stubble was filled with water, which produced stagnation of the sap, and every root died. (See Prize Essay, by the Author, in "Transactions of the New York State Agricultural Society," 1846.

CANADA THISTLES AMONG CROPS.

727. When they appear among early red clover that is to be cut for hay, the clover will be fit to cut before the thistles have matured sufficiently to go to seed. When they are among other grass, let it be mowed before the seed is ripe. When they grow taller than oats and barley, when such crops are about one foot high, mow off all the tops of the thistles. Then they will injure the growth of grain but little. Keep them from going to seed. In many sections of our country, as soon as the timber is cut off, Canada thistles spring up. In late autumn, take up every little thistle with a spade. They will be found, one in a place, just sprung from the seed. The roots have not yet spread only a few inches, and a spade will take them up root and branch. But if these solitary plants be left till next season, they will soon

spread over the entire ground. If there are many thistles, seed the land thickly with Kentucky blue grass, orchard grass and timothy; then mow them three times each year, until the stumps of trees are rotted, so that the entire ground can be plowed. This is a reliable manner of subduing this pest when the ground cannot be plowed. I have been accustomed to pull them with wooden tongs when the plants were few and scattering, and the ground soft; and have often drawn out roots eighteen inches long. Water will settle into the holes where the roots grew, and retard the growth of the remaining roots. My experience is that hands with leather mittens on are better for pulling than wooden pincers or tongs.

WINTER CRESS—SCURVY GRASS—(*Barbarea Vulgaris.*)

728. *Winter Cress* is twin brother of Field Mustard. The seed of mustard and winter cress look alike, taste alike, and possess equal vitality. Winter cress flourishes well in low, wet places, or on the dry upland. It never matures its seed in one season. The young plants will live during the winter like mulleins and bull thistles, and after fructification the next season the roots will die. It never matures its seed among spring crops, unless the plants are allowed to vegetate the previous autumn, and are not well plowed under in the previous spring. When it appears in the spring among winter crops, it must be pulled or cut off near the ground, which is quite as well as to pull it. In case there is much seed in the soil plow it, harrow it, or cultivate it often, and grow it out, as recommended for mustard. The next season, after a field is seeded with grass or early clover, if there should be much of it, as it matures before clover is fit to cut, the field should be pastured, so that the grass can be mown when it is in blossom.

729. The difference between Winter Cress and Field Mustard is, the mustard has rough, jagged leaves, and blossoms of a lighter color than cress and is an annual, while cress has smooth, dark green leaves, and is a biennial. Dr. Darlington's "Agricultural Botany" says: "It is called *Early Barbarea*, Early

Winter Cress, and Scurvy Grass. Roots biennial, stem nine to fifteen inches high. [I have raised it three feet high. Author] Leaves smooth, lower ones three or four inches long ; petals yellow ; siliques two or three inches long and slender. In some of the gardens near Philadelphia it is cultivated under the name of Scurvy Grass, as the leaves afford a medium salad." The kind alluded to, I think, is *Barbarea Praecox.* The weed which appears in many of our grain-growing districts is *Barbarea Vulgaris.*

ERADICATING PIGEON WEED, OR RED ROOT.

PIGEON WEED, OR RED ROOT.

730. Pigeon Weed, which is sometimes called *Lithospermum,* or *Stony Seed,* is a *biennial* plant, and flourishes only where winter crops are raised. Although it is a very noxious weed, as its seeds possess great vitality, and the stomachs of animals will not digest them when they are not crushed, nor will they be ground in the gizzards of fowls, still one acre of mustard or winter cress is incomparably more difficult to exterminate than ten acres of pigeon weed. The seed of pigeon weed furnishes oil similar to

linseed oil ; but it exhausts a good soil more than a crop of flax-seed will. By cultivating a rotation of *spring* crops, and by plowing and harrowing the ground in autumn, in order to promote the vegetation of the seeds, pigeon weed can be eradicated in two or three seasons, even if it has taken complete possession of the soil. Pigeon weed, like winter wheat, must have two seasons to mature in. For this reason it is never seen among spring wheat, oats, Indian corn, and barley, except in the fall after corn is cut up.

731. As some birds have the power of disgorging the contents of their crops, pigeons have been known to empty their crops of certain kinds of seed on recently sowed wheat fields, and fill themselves with wheat. No doubt pigeon weed seed is often brought to wheat fields in this manner from a great distance, as the young plants frequently appear where no such weeds have ever been seen before. When there is but little of it, let it be pulled in the spring or summer. Great care should be exercised that none of the seed is thrown among barnyard manure, or where fowls will eat it, as they will drop it among the manure. In this way the seed is sure to be carried to some cultivated field. Birds of the air often drop the seed in mellow places, where they go daily to roll. Let such plants always be pulled early in the season. When wheat is put in with a drill, men can travel between the drills to pull noxious weeds without trampling down the growing wheat.

OX-EYE DAISIES — (*Leucanthemum Vulgare.*) — HOW TO ERADICATE.

> "For who but he who arched the skies,
> And pours the day-spring's living flood ;
> Wondrous alike in all he tries,
> Could rear the daisy's purple bud ?"—T. M. GOOD.

732. The Daisy is a perennial plant, and will root out grass, until it obtains complete ascendency over all other plants. It is propagated by the spreading of its roots and by the seed. The seed will vegetate if dropped anywhere on a tough sod ; and when daisies abound in a pasture field, and are allowed to

mature their seed, cattle will eat the heads, and scatter the seed in their droppings over the whole farm in one season. They may be easily exterminated by cultivating a rotation of spring crops for four seasons, allowing no seed to mature. When a hoed crop is raised, every stool or bunch of daisies must be pulled or hoed up and the dust shook off, and when the soil is plowed the next season every stool or bunch must be buried not less than two inches deep. Pull them in the nooks of fences when the soil is wet, and throw them in heaps, or remove the fences, and plow them. If a winter crop is grown on the soil where they exist, they will vegetate in Autumn and mature their seed the next season, before a crop of grain is ripe. Sometimes timothy seed is full of daisy seed, and as the seeds are so small, it is difficult to perceive them. Dried daisies for fodder are about as nutritious as an equal quantity of fine brush. Pity the sorrows of a poor animal that is compelled to subsist on daisy hay! One crop of daisies will exhaust a soil more than two crops of clover.

OX-EYE DAISIES.

733. Sometimes very careful farmers meet with bunches of daisies in their meadows or pasture where no other weed can be

found. Where do they come from? Cattle brought the seed. I have in mind a neat farmer who kept a drove of cattle one night, which had been fed on hay, among which there was daisy seed. Wherever those cattle left droppings, a bunch of luxuriant daisies sprang up nearly two years afterwards. It was a mystery he could not solve, that they should not appear till so long a time had elapsed. The seed was dropped in January. The next spring they vegetated, and grew all the season without sending up any seed stems. Of course, daisies would hardly be noticed that season while the young plants were getting well rooted. But the next season the tall stems and large white blossoms marked the spots where the strange cattle dropped the seeds. This is one of the ways that the ox-eye daisy becomes scattered over clean meadows and pastures. Another common way is by purchasing manure and hay, and sowing grass seed, in which there is daisy seed. When there is but a little in a place, pull or dig it up before the seed is matured. That man who feeds hay with daisies in it will soon have it in every field on his farm. Most writers affirm that no seed will ever germinate after it has been through sheep. Although sheep grind their feed fine, I am satisfied they do not crush all the seed.

734. J. J. Thomas, writes: — "Many portions of the State of New York and Pennsylvania are infested with this weed. In many places we may observe the clear white of its abundant blossoms contrasting with the deep green of surrounding vegetation. It is hardy, and seems to flourish where other plants are starved; while on fertile soils it vies with the most luxuriant, endeavoring to outstrip every cultivated crop, and thus exhibiting to the passer-by the unthrift of every farmer who suffers its existence upon his soil. It is a very prolific weed, each root throwing up from sixty to seventy-five main stalks, each with half a dozen side branches, and not one without its seed head well filled with fully-developed germs for future crops of this pest of the farm. Upon stumpy land it is very difficult to eradicate the white daisy. But on land which can all be plowed while they are in early blossom, just deep enough to cover them

well, they can soon be eradicated. After the first plowing, allow the roots to dry for a few days, and then, in dry weather, plow again, being careful to plow well, and follow with a thorough harrowing. When the proper season arrives for sowing buckwheat, plow and harrow again, and sow thickly with this grain, and the daisy will be destroyed if the work has been thoroughly done. The importance of bringing the soil into full cultivation while the daisy is in blossom cannot be overstated. Turn the weeds all under before the seeds begin to ripen, and with the harrow keep the plants from taking root, and they will soon give up the contest. The seed product of the white daisy is enormous. There are not often less than one hundred and fifty heads to the single root—often five times that number, and each full to overflowing with seeds. We have found, by actual count, over four hundred; and placing the estimate at one half that number for the lowest number of seed heads per plant, we have thirty thousand seeds from one. At that rate of increase, the soil upon which they are allowed to grow will soon have room for nothing besides. Pulling them by hand, we need only undertake after a soaking rain. Their roots, so numerous and so strongly fixed to the soil, will not come up at any time without a strong pull; and when the ground is dry, the plants will break before they will loose their hold. One of the best ways to keep clear of them is to use great caution about sowing them. Every farmer should be able to detect all kinds of foul seeds at a glance. The white daisy has a seed considerably larger than timothy seed, shaped somewhat like the seed of the carrot, but smooth and destitute of fuzz. Its color is light drab and brown, in parallel stripes, running from one end of the seed to the other. When once known it is easily detected."

HORSE SORREL, SHEEP SORREL, AND WOOD SORREL.

735. Botanists have arranged the field sorrel under the head of *Rumex Acetosella* and *Oxalis Acetosella*. And although most practical farmers are accustomed to speak of sorrel as sheep sorrel, horse sorrel or wood sorrel, I have not been able to find

in any botany a plant described as horse sorrel. What is most commonly called horse sorrel, Dr. Darlington describes as sheep sorrel, and some other botanists call it common wood sorrel.

736. There are so many kinds of sorrel that it is not considered important for my purpose in this treatise to give a botanical description of them. The horse sorrel, which is often called field sorrel and wood sorrel, and sometimes sheep sorrel, may be known by its large, long leaves, of a lanceolate, hastate shape, or of a shape somewhat like a lance and spear combined. There is, usually, a kind of hook or projection on each side near the base of each leaf, which are always long and narrow. On rich soils I have often seen them three inches long. The leaves are usually very tender, and children as well as adults eat them with avidity; although too much of them would be injurious, on account of the large quantity of oxalic acid which chemists tell us exists in the leaves of sorrel.

737. What is commonly called sheep sorrel has leaves very much like sweet clover, and the leaves are very tender, and are relished much better than the other kind of sorrel, as the acid taste is more delicate. This kind of sorrel is often met with when harvesting spring wheat, oats or barley. It grows in little tufts, and at first sight looks a little like a tuft of young and tender clover.

738. Both kinds are found along fences where the soil is mellow and the grass has run out; and sometimes they are about the only herbage that will grow in certain portions of a cultivated field. Sometimes large stems will be sent up from one to two feet high, full of seed, which, if allowed to mature and fall to the ground, will remain in the soil for many years, unless it is so near the surface that the moisture and heat are just right to cause it to vegetate. Sorrel is by no means a troublesome weed, providing one understands its habit and knows how to eradicate it.

739. Sometimes when soils have been impoverished by a bad system of management, so that it is difficult to seed it down with any kind of grass, sorrel will take complete possession. It is a

very hardy plant, and will flourish on barren places where no other green thing will attempt to grow.

HOW TO ERADICATE IT.

740. In the first place, keep it from going to seed. Then cultivate the soil well, and manure it abundantly for a few successive seasons, and sorrel will give no farther trouble. Sorrel never flourishes luxuriantly on a soil that will yield three tons of hay per acre, or thirty bushels of wheat, or eighty bushels of oats, or eighty bushels of shelled Indian corn per acre ; because cultivated plants will soon supplant it. Red clover, for example, and orchard grass will grow so quickly, if the soil is not too barren, that sorrel will be effectually choked out.

741. Now, suppose there is more sorrel in a field than there is anything else. Haul on as much barn-yard manure as can be plowed under conveniently, and plant it with Indian corn, and cultivate it well, letting none go to seed. Should it come up thickly in autumn, and be forward enough to go to seed before winter, let the ground be plowed next spring, and about the first of June plow the ground again, and on a dry day harrow it thoroughly. About the first of July plow again, and sow buckwheat. In autumn give another coat of manure, if the soil is not already rich enough, and the following spring plow again, and sow spring rye, and seed down with red clover and orchard grass. Sorrel will give no more trouble, if treated in this way, until the grass has begun to fail. This is a rare plant on a farm, where a good rotation system has been adopted.

EXTIRPATING SORREL BY APPLYING LIME.

742. The scientific remedy for killing sorrel is an application of lime to the soil where it grows. The agricultural chemistry of this lofty philosophy is, that there is oxalic acid in the sorrel, and there is an excess of it in the soil. Therefore an alkali (there is alkali in lime) must be applied to the soil for the purpose of neutralizing this oxalic acid, which is found only

in the sorrel. Distinguished agricultural chemists have recommended this practice for the certain extirpation of sorrel from the soil! And credulous and honest farmers, who thought themselves very ignorant, have applied lime bountifully for that purpose; and editors of agricultural papers have reiterated this remedy as the only infallible panacea for the extirpation of sorrel!

743. If an old superannuated grandmother, who never saw any books except her Bible and the Babes in the Woods, could not give a more philosophical and practical remedy for the extirpation of sorrel than the application of lime for the purpose of neutralizing the oxalic acid that might be formed in the sorrel, any one might be justified in denominating her a demented old dotard. One might, with the same propriety, apply lime to the roots of currant bushes, for the purpose of neutralizing the acid that we taste in currants.

744. It is indeed passing strange that wise chemists should have fallen into such a blunder as this. Oxalic acid does not exist in the soil. Therefore what folly to apply an alkali to neutralize an acid that is not there. It is no evidence of a sourness in a soil because it produces sour and bitter plants. The acid is formed in the growing plant. It is not absorbed from the soil by the roots of sorrel and conveyed up into the leaves; and it is ridiculously absurd to assume that lime may be applied as a remedy for the extirpation of sorrel.

745. This position is well substantiated by the fact that sorrel has often been seen to grow luxuriantly in close proximity to lime kilns, where lime had been applied at the rate of several thousands of bushels per acre. All the effect lime can have in extirpating sorrel will be produced by preparing the soil by way of fertilizing it for other plants which will overgrow and supplant the sorrel.

746. Since writing the foregoing paragraphs, I was pleased to meet with the following remarks in the *American Agriculturist*, previous to my editorial connection with it:—"Lime is often recommended to kill out sorrel; the alleged reason being that

the oxalic acid in the sorrel shows that the soil is sour, and to remedy this we must apply an alkali, like lime. Doubtless good often comes from such application of lime, but not for the reason here given.

747. The presence of oxalic acid in sorrel is no better proof that the land is sour, than is the acidity of the apple or of the rhubarb plant. The same ground which grows a sour apple will grow a sweet one; the two often grow on the same tree. The vegetable acids (of which oxalic is one) are produced in the organism of the tree or plant, and not in the land. True, the elements of the acid are gathered from the soil and air; but they do not exist in the acid form which we find in the plants. These very elements, when taken up by a potatoe plant, form starch. When taken up by a corn plant, form sugar, and when taken up by a grape vine, form tartaric acid. If the soil itself be as closely examined as science will permit, there will be found neither the starch of the potatoe, the sugar of the corn, the cream of tartar of grapes, nor the oxalic acid of sorrel. In view of these facts, then, it is useless to apply an alkali to the soil to neutralize an acid which does not exist there. But is there, then, no way of eradicating sorrel? Yes. It spreads like quack-grass and Canada thistles, chiefly by underground stems with numerous joints, each of which will form a plant. Break up the land in July and August and put in a crop of buckwheat or rutabagas; and the intruder will be pretty well snubbed out. A corn crop, or other hoed crop, if well drilled in mid-summer, will answer a good purpose. Dressings of the soil are also very important. Applications of lime are useful to decompose vegetable matter, and so to 'warm up' the land and quicken the growth of plants. Chief of all in value is barn-yard manure applied copiously and well worked in. This gives strong food for the vigorous growth of other plants than sorrels; and when they occupy the land, this badge of an impoverished soil will disappear."

THE SHEEP LAUREL.—(*Kalmia Angustifolia.*)

THE SHEEP LAUREL.

748. This plant, which is common on hill sides and in pastures, is known by the names Sheep Laurel, Lambkill, and Dwarf Laurel. It is a small evergreen shrub, about two feet high with slender branches. The leaves are light-green, pale on the under side, and of the size and shape shown in the engraving, which represents a flowering branch of the natural size. The flowers are crimson, and though not particularly showy, are, upon close inspection, curious and beautiful. I notice this shrub on account of its alleged poisonous effects when eaten by sheep. The very general impression that it possesses poisonous qualities is indicated by two of the popular names quoted above; but after a pretty diligent search for authentic statements in regard to its deleterious qualities, I find the accounts vague and unsatisfactory.

749. Mr. L. A. Morrell, author of the *American Shepherd*, states that it is poisonous From the antidotes pub-

lished from time to time by the agricultural papers, I infer that it is at most a weak poison.

750. The best manner of exterminating it is to mow it close to the ground early in the season, and as often afterwards as it is large enough to be mowed. This will subdue it in pastures and meadows until the ground can be plowed and hoed. One four-years rotation of crops will exterminate the last vestige of it, if the work be well performed.

TOAD-FLAX.

751. Within the remembrance of many of our readers there was a plant cultivated in gardens as an ornament which bore the popular name of "Butter and Eggs." It has quite disappeared from our gardens, but has taken up its abode in fields and meadows, and along the roadside, where it not only flourishes without any care, but strongly resists the efforts made to get rid of it. The engraving shows the upper part of a stem with the flowers—the whole stem being from one to three feet high, and bearing below long and narrow leaves, like those shown in the figure. The structure of the flower is quite curious, and will repay examination. The four stamens and the pistil are quite hidden within the flower. The pod, instead of splitting when ripe, opens one or two holes in its sides to allow the seed to fall out. The leaves are of a pale green, the flowers of a light yellow color, except the palate, which is of a bright orange. This contrast of colors doubtless gave origin to the name "Butter and Eggs." But the most important part of the plant is the root, which is woody, creeping, and very tenacious of life,—qualities which render it a troublesome weed. In some places the notion prevails that the more its destruction is attempted, the faster it spreads ; and with this view patches are sometimes left in the fields for fear of making matters worse by disturbing them. This belief has some foundation in fact, and there is no doubt that plowing and harrowing will break and scatter the roots, every piece of which will start and form a plant. But a field infested

with this, or similar weeds, should be kept in hoed crops until the evil is exterminated. In Pennsylvania, the plant is known as Ranstead-weed, on account, it is said, of its introduction there by a Mr. Ranstead, who, many years ago, cultivated it in his garden. The name Toad-flax is the one by which the plant is known in England; and as it is very desirable to preserve uniformity in popular as well as botanical names, we give it the preference over the others. To eradicate, never let a plant go to seed. Mow it in pastures and meadows, and plant Indian corn one year, and sow buckwheat the next. This will destroy it.

TOAD FLAX.

When single plants first appear, pull them before they blossom. When mowing grass, if any has matured its seed, cut it up with care, and burn it or destroy it.

When this plant appears in old pastures, plow the ground, manure well, and seed with orchard grass and Kentucky blue grass and red clover.

CHESS OR CHEAT.—*Bromus Secalinus.*

752. I doubt whether there is another plant in the world

that has elicited so much discussion as this. It is my purpose to show what chess is, how it may be identified when seen, and how exterminated. Thousands of good farmers do not even know it when they meet with it. The illustration represents the full size of a large panicle of the grain. By comparing this representation with a growing specimen, any one will be able to recognize it. The little *awn*, or bristle to the chaff of each grain, varies much in length, being sometimes longer than is shown in the engraving. Although the chess grows luxuriantly, it can not be considered other than as a worthless weed, which should be carefully eradicated. An attempt was made some years ago to introduce it under the name of Willard's Bromus It was found to yield a large quantity of fodder, but its quality was shown by direct experiment to be poor. Cows having equally free access to the bromus, or chess, and swale hay and corn-stalks, invariably neglected the chess.

TRANSMUTATION OF WHEAT TO CHESS.

753. There is a mystery about the phenomena that farmers some times meet with concerning chess. Some men have scouted at the idea that wheat will ever produce chess. Editors of agricultural papers have denounced intelligent farmers as consummate ninnies because they have sometimes been induced to believe that the wheat plant has sometimes produced chess ; and I suppose I shall be denounced as an ignoramus for appearing to acknowledge any thing of the kind. But *facts* are stubborn things. I cannot affirm that wheat never does produce chess. I have seen chess produced where, had it not been for my knowledge of botany, I would not hesitate for a moment to say that the chess sprang from wheat. My botanical knowledge assures me that wheat never produces chess. And I think that is correct :

QUERY.—An ox broke into a field of wheat early in the spring and cropped off the spears for several feet square where he entered the enclosure. Wherever he ate off the wheat, large chess appeared. The ground was quite soft where he walked

across the field ; and stems of chess grew around every track ; and no chess could be found any where else in the field. Who will explain to me whence came the chess ? In another instance, there was a hollow in the field where wheat was sowed, which covered an area of several square rods. Water would often stand several inches deep in this hollow, and freeze and thaw until it had all evaporated. Good wheat grew up to the point where the water covered the ground. Below the water-mark, nothing but chess appeared. If this is not a poser for botanists, I am no judge of wheat and chess. I ask, where did it come from ? You say, and I also say, that it never sprang from wheat. It was never sowed there. Has any one ever sowed chess, for a succession of years, to produce wheat ? With all my knowledge of botany, I dare not affirm that nice wheat *may* not be produced from chess ! It is said that our peaches originated from almonds. Is it any more incredible that wheat should have sprung from chess? Who can deny it ? and at the same time give us indubitable assurance that it is not so ?

754. If we let some kind of turnips remain in the ground all winter and go to seed the next season, the product will be nothing but tops. It may not *always* be so. But I have always found this *not to fail.* This is a fact. Now, then, I ask botanists to explain it on philosophical principles.

755. Botanists agree, that as chess belongs to a distinct genus from wheat, the possibility of its ever changing from one to the other is effectually excluded. Chess is very prolific. One seed will often bring forth a thousand-fold. The kernels will pass through the stomachs of animals, the gizzards of birds and domestic fowls without losing their vitality. They will often remain in the ground for years, and then grow when it is brought near the surface of the ground. J. J. Thomas affirms in the *Annual Register*, that " chess will often grow not more than two inches high, and perfect the seed," which seems almost incredible. It is easily eradicated by raising none but *spring* crops, and sowing none of the seed with winter grain. A good fanning mill will blow it all out, as it is much lighter than wheat

or rye. Then, do not feed it to fowls or stock until it is ground or boiled. There is so little nourishment in it, that it is hardly worth grinding into meal.

BURDOCK—(*Lappa Major.*)

757. No good farmer will allow this coarse and disagreeable weed to flourish on his farm. After a few plants have been allowed to go to seed, a long time will elapse before they can be exterminated. As burdock is a biennial plant, the seeds germinate one season, and produce seed the next season. After this, the root and all dies. Burdock is seldom seen in cultivated fields. In neglected nooks, where the ground is rich and bare, burdock will supplant every thing else.

758. The best way to eradicate the plants is to cut them with sharp hoes, two or more inches below the surface of the ground, late in autumn, when the water will enter the roots and destroy them. If the ground where they grow can be plowed, they may be easily exterminated, unless there is much seed in the soil, which a few years of cultivation will destroy by vegetation.

WILD MUSTARD—CHARLOCK.—(*Sinapis Arvensis.*)

759. A branching, annual plant, two to six feet high. Lower leaves deeply lobed, and varying much in their shape, the upper ones not lobed, but toothed or notched. Stem and leaves rough with scattered hairs, which generally point backwards. Flowers bright yellow, numerous, appearing from June till August, consisting of four small *sepals* and four large yellow petals, the latter narrowed into a long claw at the base, the other end ovate, with generally a slight notch in the end. Pods one to one-and-a-half inches long, tipped with the dried *style* of the flower. Seeds numerous, round and black. Plant varies much in different situations. In some places it is six or seven feet high, very branching, and producing thousands of seeds; and in dry, hard soils I have seen it but a few inches high, tipped with a single flower. Most abundant in the central and western part of the state of New York, where it is a great nuisance.

THE DANDELION.

The root is employed medicinally, and is one of the many articles used as substitutes for or to mix with coffee. The plant is botanically related to both chicory and endive, and is used in a similar way. Those who value it for greens will find it much better to cultivate the plants than to depend upon those which grow spontaneously, as they are superior, and are always at hand. When the root is required, it should always be taken up in the fall, as then it contains most of the milky juice upon which its properties depend. The seed is sown in May or June, in well prepared ground, in drills twelve or fifteen inches apart. Thin to three or four inches, and keep the plants well cultivated through the season, and they will be fit for use in the following spring. According to Burr, if the dandelion is cultivated for its root, the sowing is done in October, the plants thinned the following June, and kept free from weeds during summer, and the roots harvested the next October by plowing them out. The roots are prepared for market by washing, slicing and drying them." As the dandelion is a perennial plant, and springs from the seed, it is only necessary to cultivate land well, with a three or four-years rotation of crops, to effectually exterminate it.

MAY WEED—DOG'S FENNEL—STINKING CHAMOMILE—(*Maruta Cotula.*)

761. Stems very branching, six to sixteen inches high, smooth or somewhat grooved. Root lives but one year. The leaves are much divided into very narrow divisions. The ends of the branches are leafless, striated and terminated by the heads. These are about half to one inch in diameter, and consist of about a dozen strap-shaped white *rays*, and a convex or sugar-loaf-shaped yellow disk. The rays have generally a slight notch in the end, the wider ones sometimes *two*, and at first spread horizontally, but turn back towards the stem as the flower matures. The disk, which is generally a quarter to three-eighths of an inch in diameter, is composed of numerous small yellow tubular flowers, each surmounting a smooth ribbed or grooved seed. The heads produce from a small number to two hundred seeds each; ordinary sized ones about one hundred and forty. The whole plant is strongly scented.

762. Linnaeus says that "it is grateful to toads, drives away fleas, and is annoying to flies." It blossoms from June to September. Originally introduced from Europe. It is abundant by road sides, in waste places, &c., presenting a whitish surface when in bloom. It varies greatly according to the circumstances under which it grows. I have seen it of large size, producing three hundred and fifty heads and many thousands of seeds when it grew in a good locality; and on the other hand, when under less favorable conditions, but an inch high; in one case but three-eighths of an inch, producing but a single small head. Many farmers think that it exerts, by its odor, or more probably by the *pollen* of its flowers, a positively injurious or blighting influence on wheat; but the majority maintain that in this respect it is harmless. It is easily eradicated by thorough cultivation.—*W. H. B., in Country Gentleman.*

763. In some of our wheat-growing districts there is a pernicious weed similar to this May Weed, whose seeds vegetate in autumn; and the next year the plants grow very large and thick, some times one and a half feet high, rendering it almost impossible to cradle the grain unless it is cut above this weed. Whatever may be the name of the weed, it may be easily exterminated by raising nothing but spring crops, as it will not mature seed unless the young plants start the previous autumn.

MILK WEED—(*Asclepias Cornuti.*)

764. Milk weed is a perennial plant. It is much more difficult to exterminate than Canada thistles, on account of its running roots, which strike deep in the soil, often extending two or three feet below the surface. They are also very tenacious of life, sometimes sending up strong stems two or three years after they were all thought to be exterminated. When milk weed is cured with hay, all kinds of animals like to eat of them for a variety; but they soon lose their relish for them.

765. This weed may be recognized by its straight, erect and smooth stem, and large, smooth leaves, out of which a white juice exudes when any part is cut or pulled asunder. The stems

often grow four or five feet high on rich land, and nearly one inch in diameter. The flowers are greenish purple, in umbels, and quite numerous. The seed vessel is a follicle or large pod, several inches long and an inch or more in diameter, on large stems. The seeds are very light, and are attached to a fine, hair-like substance, which bears them up in the wind as they are wafted over the fields.

766. The most effectual way to eradicate this weed is to manure highly and cultivate some hoed crops for two or three successive seasons, allowing none to blossom. If they are allowed to blossom, the roots acquire new life and strength to send up stems the next season. When they cannot be cut up with hoes, let them be pulled. By keeping them subdued for a few years, they will be so few and scattering as to do little harm.

COCKLE—CORN COCKLE—(*Agrostemma Githago.*)

> "Of these the husbandman takes certain note,
> And in the proper season disinters
> Their baneful roots; and to the sun exposed,
> Leaves them to perish in the noonday."—READ.

767. This plant is said, by professional botanists, to be both an annual and a biennial. I have been familiar with it for forty years, and never have known it to mature in one season. It was always found among winter grain; and never with spring grain. The seed germinates late in the summer, or in autumn, and the plants mature the next season. The *Fig.* given in next page represents a portion of the plant in blossom. At the left side of the figure a portion of a capsule is shown, cut in two parts. One of the seeds is represented between the capsule and the plant. The seeds are black, and sometimes almost round; and it is difficult to separate them from wheat, unless the kernels are very large, as small grains of wheat will pass through a sieve that will take out the cockle seed. It is not difficult to exterminate. If no seed is sowed with grain, there will seldom be any cockle. When it does appear in the spring, as soon as the plants are about one foot high, let them be pulled up. Should any escape notice till harvest,

they may be separated readily from the straw of the grain before

COCKLE—CORN COCKLE.

the seed shells out. Such black seeds detract from the appearance of the cleaned grain more than they injure the flour.

FLEA BANE—(*Erigeron Strigosum.*)

768. This worthless weed appears sometimes in meadows and pastures, growing thick and tall, often rooting out the grass, so that it is not worth mowing. Some botanists call it an annual.

But it is not, as I have frequently seen the young plants start one season where there was not a plant to be seen; and the next season the meadow would be white with the tall weeds in blossom.

769. It grows from two to four feet high, on a tall, slender stem with white blossoms at the top, somewhat like the blossoms of the daisy, but much smaller. (See Darlington's Ag. Botany) The true way to eradicate it is to let none go to seed. Before grass is fit to cut, clip off all the flowers of this weed as soon as they blossom. Mow them in pastures, and let none of the seed be scattered on the ground, nor gathered with hay-seed, or find its way among manure into cultivated fields, and it will shortly disappear from the farm. The seed of the plant is often sowed with red top and Kentucky blue grass seed. Those farmers who raise their own grass seed with care, and who cultivate their land thoroughly, will never be troubled with flea bane.

770. When it appears among early red clover and orchard grass, they will be fit to mow long before the flea bane has matured the seed. When it grows among timothy grass, most of its seed will ripen before the timothy is fit to cut. Should there be but a limited number of plants, it would be best to cut them all out of the standing grass. Sometimes a second crop of this weed appears in meadows. This is apt to be the case when the weeds were cut before they were in full bloom. Let them grow till the blossoms are well developed, then mow them and rake the stalks in large heaps. If left where they grew, many of them will mature the seed even after they are cut down. Treat them in the same manner when they grow in pasture fields.

DOCK—SOUR DOCK—CURLED DOCK—(*Curled Rumex*)—BITTER DOCK—BROAD-LEAVED DOCK—(*Obtuse-leaved Rumex.*)

771. For the botanical description of the different kinds of dock, see Gray's Botany or Darlington's Ag. Botany. It is difficult to describe the different kinds of dock so that beginners will readily perceive the difference between them. Dock of any kind is a pernicious weed. Professional botanists say the root is perennial. It is not always. I have known it to be a biennial and

triennial, and rarely a perennial. The large, long tap roots are very tenacious of life. If pulled up and dropped on the ground in damp weather, they will all take root and grow rapidly. Good cultivation will soon exterminate it. Let none go to seed, and it will not survive many years. When it grows among grain, the *best way to exterminate it is to pull it, when the soil is very wet,* throwing the stalks in large heaps. Mowing it twice a year in pastures, if cut before the seed has ripened, will usually destroy it till the ground is again plowed, when a new crop *may* appear should there be seed in the ground.

772. Sometimes young dock will come up very thick among Indian corn and other hoed crops. Root them up with cultivators and hoes, late in the fall and the next spring plow them well under, with deep furrows. All that are buried deep will die. Those that are near the surface will live, and must be pulled up at any time before they go to seed. Mr. T. W. Colburn, a Vermont farmer, writes of Yellow Dock: It is about twelve years since they made their appearance in my fields. At first I paid but little attention to them, for they did not increase fast ; but after getting the seed into the manure, they began to multiply rapidly, and in making some effort to subdue them I found they spread and propagated from the root as well as the seed. I began to feel alarmed, for they were becoming very numerous in all my grass lands, and how to get rid of them I did not know, but formed a resolution three years ago to wage a war of extermination in some way. I purchased a pair of stiff heavy plate subsoil spades, sixteen inches in length ; I ground down the lower edge sharp, and after the haying season was over, put two men at work in the fields, cutting them off from six to ten inches below the surface, and then pulling up the part of the root thus separated with the fingers, and after letting them lay upon the ground until wilted, put them into a pile on the side of the highway. I employed these men for the most part of three weeks in this operation, and gathered a large quantity of these roots which have rotted down on the roadside, and they have never appeared above the surface where they were cut in the ground. Some small ones escaped

the eye of the workers, and seed was in the hay of that year so that I must repeat the operation this year, but there is not one now where there were five before I cut them three years ago. I believe if they are cut off six inches below the surface, pulled up and removed from the field, it will stop them; they will not sprout or vegetate from the part of the root left in the soil. The part left is too far below warmth, light and air to start into life anew.

773. Such weeds should never be carried to the highway, as they will make good manure. If Mr. Colburn had cut the dock alluded to, only two inches below the surface with broad hoes, the roots would have died as effectually as if cut with spades; and the labor would have been very much less.

THE COMMON THISTLE—BULL THISTLE—(*Cirsium Lanceolatum*.)

774. This repulsive weed is a biennial. The seed is scattered by the wind over the country, in the latter part of summer and autumn; and if it falls on sod ground it may vegetate, but will not take root. But when it falls on broken soil or ground where winter grain has been put in, the young plants appear with the wheat in autumn, and the next season there will be large, well matured thistles among the standing grain. If a field is stocked down to grass, large thistles will be found among the grass. But the roots always die after they have survived one winter and the following summer.

775. This thistle always starts from the seed, and never from spreading roots. As every seed is attached to a downy pappus, which subserves the use of wings, the farmer who is exceedingly careful not to allow one to go to seed on his farm, has no security against this thistle appearing among his winter grain or new meadows. The best and most effectual way to eradicate them is to put on leather mittens, and pull them, late in the fall, in the winter or spring, when the ground is soft. This will be the end of them. Should the ground be firm, and the roots strike so deep as to make them pull hard, cut them off with a sharp spade or sharp mattock having a broad blade, at least three inches below the surface. Then the roots will die. If the tops only be cut

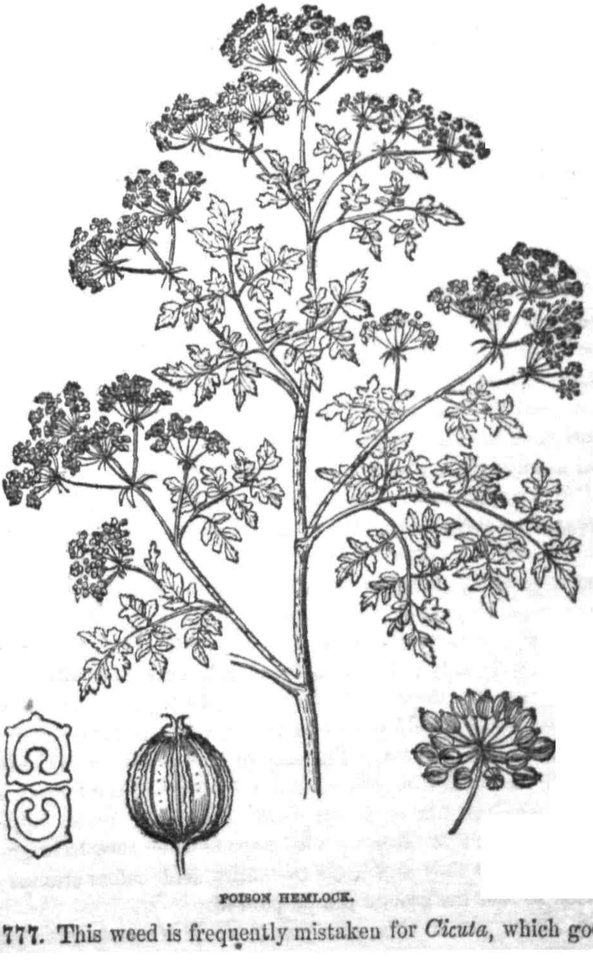
off, the roots will often sprout again. After the buds are formed, mow them, and let none go to seed. But when they are cut up by the roots there will be none to mow. This kind of thistle may be exterminated in the winter as well as summer.—See botanical description of this thistle in Dr. Darlington's Ag. Botany.)—Besides this thistle there are the Yellow Thistle (*Cirsium Horridulum*) and (*Cirsium Pumilum*), none of which are half so prolific as the *Cirsium Lanceolatum*. They are all biennial plants, and may be exterminated in the same manner as detailed in the preceding paragraph. The Yellow Thistle is seen so seldom that it appears more like a curiosity than a noxious weed to be exterminated.

POISON HEMLOCK—(*Conium Mucalatum.*)

776. The accompanying figure represents a stalk of Poison Hemlock, sometimes called *Conium* or *Conia*. At A, is one of the panicles. B, represents a seed receptacle. At C, a transverse section of a seed is shown. This is by no means a difficult weed to exterminate, although some farmers dread it far more than the Canada thistle. It grows only in waste, neglected and uncultivated ground. It is a perennial plant.

When this weed is about two feet high, it sometimes has the appearance of Sweet Cicely. I have frequently heard of children who, having mistaken this root for Sweet Cicely, have eaten it, and were badly poisoned by it. When the two plants grow in close proximity, they should be placed side by side, and the botanical points of difference closely noted. In this way even children will easily perceive the real difference, and will be able to recognize it without any hesitancy. The fragrance of the roots of Sweet Cicely is always a certain index of one great difference between the two plants. The seed of poison hemlock (*Conium*) as well as Sweet Cicely is scattered by birds in the forest; and as soon as the timber is cut away, the young plants appear. Let every plant be taken up with a spade when they have grown one season, or they will cover the entire field before stumps are rotted so that the ground can be plowed.

Mowing close to the ground, as often as it grows large enough to blossom, will destroy it in two seasons. By plowing the ground, planting a hoed crop, and cultivating well for one season, it will effectually be exterminated.



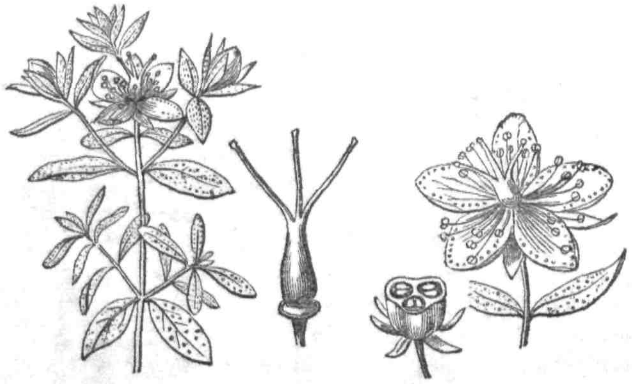
POISON HEMLOCK.

777. This weed is frequently mistaken for *Cicuta*, which goes

by the names of Beaver Poison, Musquash-root and Spotted Cow Bane. Some knowledge of botany is essential to understand the difference between these two weeds. They are both very poisonous. I have frequently read of children being poisoned to death by eating the roots, supposing they were Sweet Cicely. When the leaves or stems are cut or bruised they emit a very sickening and offensive smell. Gray's Botany will enable one to perceive the difference between the two plants by examining a specimen of each and comparing them.

JOHN'S WORT—(*Hypericum Perforatum.*)

778. The illustration herewith given shows a portion of a stem of John's Wort. A, is a blossom, which is yellow or orange-colored. B, is a ripened receptacle of seed. C, represents a cross section of a seed vessel. This weed is a perennial, growing from one to three feet high in meadows and pasture



JOHN'S WORT.

fields. It is easily exterminated by good cultivation, and not allowing any to go to seed. When allowed to mature the seed in pastures, cattle will sometimes swallow more or less seed and drop it about the fields. When mowed with grass, the seed all goes among the manure, or a portion of it is sowed with grass

seed. Let none go to seed; cultivate the soil well, and John's Wort will give no trouble.

THE FIELD HORSE-TAIL.— (*Equisetum Arvense.*)

779. Under the name of Pine-Wood and Low-Pine, the Field Horse-Tail has been, of late, considerably discussed by agricultural journals and inquired about. The interest in the matter arises from the fatal effects upon horses which have been ascribed to it. As some of those who have written upon the subject have been talking about a widely different plant, the Mare's-Tail, I give figures of the one in question, *Equisetum Arvense*, the Field Horse-Tail. The common name in this case is a translation of the botanical one. *Equisetum* is from the Latin, *Equus*, a horse, and *seta*, a bristle, and refers to the hair-like character of the branches of some species. The Horse-Tails are what botanists call *cryptogamous*, or flowerless plants, as, like the fern, mosses, etc., they have no true flower with stamens and pistils, and they do not produce seed; but, in its place, spores, which are very small round bodies, like dust, by means of which the plants are multiplied. The species under consideration presents two forms which an ordinary observer would never take to belong to the same plant. In damp places, in April and May, are found numerous simple stems like fig. 1; they are hollow, grooved, of a light brown color, having at each joint a sort of sheath of a darker color. At the top of the stem is a head, shaped like a pine-cone, made up of scales, which bear the spores on their inner surface. After the stems above described have shed their spores, they die away; and later in the season the

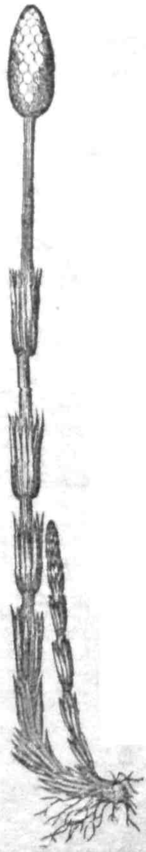
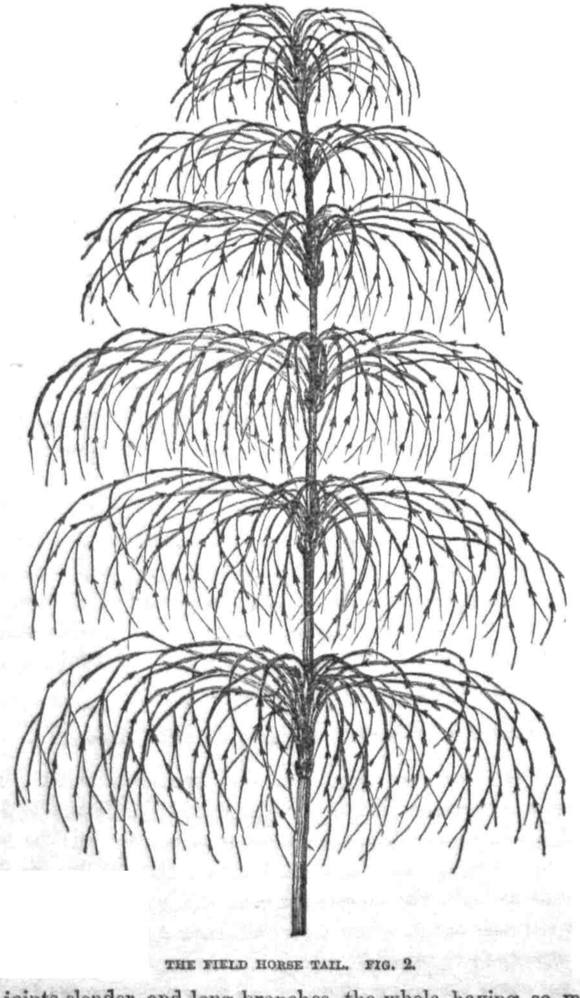


FIG. 1.

fig. 2, and are eight to twelve inches or more high. These, as well as the fertile ones, are grooved and hollow, and bear at



THE FIELD HORSE TAIL. FIG. 2.

the joints slender and long branches, the whole having so much

the appearance of a miniature pine tree as to suggest the popular names of Low-pine and Ground-pine. With regard to the poisonous qualities of this plant, we are in the same uncertainty as we are respecting the Sheep-Laurel, noticed in another article.

The testimony is most conflicting, some saying that it is harmless to all domestic animals except horses, others that it harms only cattle or sheep, and others again that it furnishes, in some places, the chief forage. With regard to the poisoning of animals, I am inclined to be a little skeptical, as their instinct generally leads them to avoid injurious plants. If a certain plant is poisonous, its effects should be studied, and its proper antidote known; then the farmer would not be harboring a poisonous plant, nor suspecting an innocent one as the cause of every fit of indigestion his animals happen to have, and he would not waste his time and the animal's strength by trying various foolish and empyrical remedies.

780. I remember well, when a small boy, that in one of my father's meadows numerous weeds appeared every summer, which were cut with the grass and made into hay. They were called by the men, "Pine-Weed." For many years the grass of that meadow was made into hay with countless numbers of this weed. I never heard, until recently, that any one even supposed that this weed was poisonous. Our horses, neat cattle and sheep eat the hay and the pine-weed without injury. This weed is usually found on low grounds, where it is rather wet. Draining and good cultivation will soon exterminate it.

RAG-WEED OR BITTER WEED.—(*Ambrosia Trifida.*)

781. There are two species of this pernicious weed. The Ambrosia Artemesiæ folia is so near like the Ambrosia Trifida that it is sometimes difficult for those who are not familiar with plants to distinguish the difference between them. But as they are both annuals, the same treatment will exterminate either. Rag-weed does not do much injury till haying and harvest, when it springs up in the stubble, and in meadows when a tough sod does not cover the entire ground; and sometimes grows so rapid-

ly that there is nothing but a heavy growth of this weed to be seen. After the last hoeing of potatoes and Indian corn, Rag-weed spreads its branches so that every other weed and grass is over-topped, and choked down.

RAG-WEED OR BITTER WEED.

782. It is not difficult to eradicate. Let none go to seed. Mow it in meadows and pastures as soon as it is in blossom, when the stalks are wet, and rake it in large heaps, where seed and all will rot. In corn fields it must be pulled or mowed and

gathered into large piles, or the seed will be scattered on the mellow soil, and will not vegetate, unless in a favorable place in the soil, in less than ten or twenty years.

783. When it appears in wheat or barley stubble, either plough the ground or cultivate it a few inches deep, so as to root up every plant. This plant never spreads from the roots. Therefore when a stem appears let it be pulled. Let men go through corn fields and pull the scattering plants before it has taken possession of a field. By this precaution it may be kept out of cultivated fields with little difficulty. But let the solitary plants, which are seen at first far apart, mature their seed and scatter it over the ground, and there will be weeding enough for many years.

COMMON MULLEIN—(*Verbascum Thapsus.*)

784. No good farmer is troubled with mulleins. The seed possesses great vitality. When nothing else occupies the soil, mulleins appear. I well remember plowing a piece of sod ground which I knew had not been broken up for over thirty years ; and mullein plants covered the ground with their large leaves before autumn. The next season, after there is a good system of leaves and roots formed, they send up a tall, slim stem, from one to seven feet high, with no branches. It is the most prolific plant I ever met with. The seeds are very small, and numerous as the divisions in the eye of a horse fly. Mulleins cannot mature their seed where spring crops are grown. If they have been allowed to live during the winter, pull or cut them below the surface of the ground. But let none go to seed. If mulleins ever spring up in cultivated fields, where there is but little herbage, if the soil be heavy, plow it deep in autumn, and the next spring sow three bushels of Indian corn for a crop of green manure. (See Paragraphs 683 and 684.)

QUACK GRASS—COUCH GRASS—QUITCH GRASS—(*Triticum Repens.*)

785. As this plant is one of the grasses, it ought properly to be noticed in a Chapter on Grasses and For ge Plants.

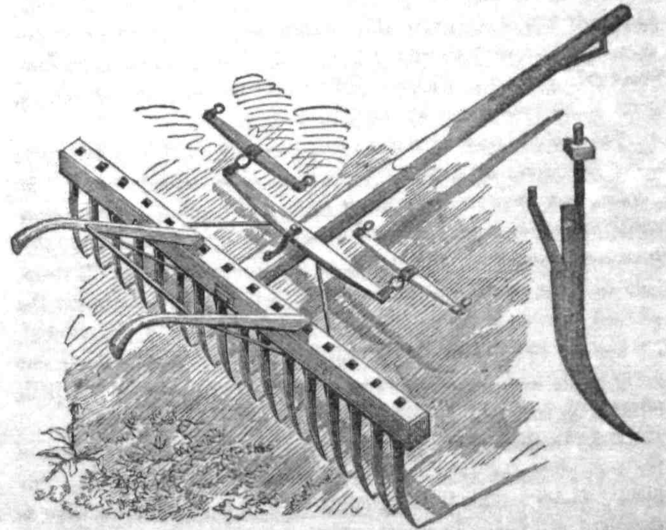
Still, as it is far more important to know how to exterminate than to cultivate such a pest of our grain farms, I have ranked it among noxious weeds. I have nothing to pen in favor of such grass. It is a coarse, ugly, disagreeable grass for stock; and it makes very inferior hay. The common name accepted by European and American authorities is Couch-grass, and though in some localities it is called by other names, such as Quack, Quick, Quitch, we prefer to adhere to the established name, Couch-grass *Triticum Repens.*

786. It is a perennial, and spreads rapidly by its numerous roots, which increase so fast as to supplant everything else, often becoming such a tangled and dense mass in the soil that it is difficult to plow the ground, unless the plow is provided with a sharp coulter and share, and driven below most of the roots. It is also propagated by the seed. Some farmers, fancying that it would be an excellent grass to cultivate, have sowed the seed and made hay of the grass, after which the seed has been scattered in the manure over many fields. Although quack is exceedingly difficult to exterminate, still it may be killed in one season, *if faithfully attended to at the proper time.*

787. When there is but a limited amount of it in small plots in various parts of a field, the best mode of exterminating it is to plant Indian corn two years in succession; and the first season cultivate and hoe it every two weeks, and haul out all the roots that are loosened by the horse hoe, and knock the earth off them, leaving them to die on the surface. The next season, when the ground is plowed, should there be any live roots in the ground, let one or two hands follow with potato hooks, and haul out every root, and gather them in a large heap to decay. A little labor with hoes and potato hooks will completely destroy it.

788. In those fields where it has taken complete possession of the soil, plow the land deep in autumn, turning the quack completely under. This plowing must be well performed, or the experiment will fail. The next season, as soon as the young grass has appeared, like wheat about two weeks old, cultivate the ground, or go over it with a gang plow, having sharp edges, so

as to cut off every young plant. Continue to cultivate until the time arrives for sowing buck-wheat. As soon as the buck-wheat is cut and set up in stooks, cultivate the ground twice, thoroughly, and continue to do so till winter as often as the grass grows 3 or 4 inches high. The stooks of buckwheat may best be removed from the cultivated ground in order to keep the grass subdued while the buck-wheat is curing. The next season, if much remains in the soil, summer fallow the ground, and rake out the roots with a couch-grass rake. This treatment will subdue it so effectually, that the next year the ground should be summer fallowed. The plowing should be done with narrow furrows, and the roots raked out and gathered in heaps. Some farmers put two horses, tandem, before a sulkey hay rake, and rake the mellow soil, leaving the roots in rows. Others make a strong iron-toothed rake, represented by the illustration, having a



COUCH-GRASS RAKE.

head about four feet long, and four by four inches square of hard

wood, with strong iron teeth fastened in the head, guided by a tongue, and drawn by two horses. The teeth are about six inches apart and ten long, and made of the best Swedish iron, $1\frac{1}{2}$ inches wide, by $\frac{5}{8}$ of an inch thick, drawn to a point, and hammered to a coulter edge on the forward side. The upper ends are made with a strong nut and shoulder-brace, as represented by the enlarged figure of a tooth, at the right hand side of the engraving. The teeth are about ten inches long below the head. The holes for the shank should be bored three-quarters of an inch from the forward side of the head, and the holes to receive the rounded end of the tooth brace should be only 1 inch deep, so that the ends of the braces will extend to the bottom against the solid wood. If there are roots of trees and stumps, or fast stones in a field, the teeth may be heavier; although with careful usage, the size designated will make the rake heavy enough and sufficiently strong. The hilts of the handles should be so low that a man can stand erect and just grasp them with his hands while the teeth are in the ground and the end of the tongue as high as the neck-yoke. If the handles are too high, it will be much harder work to hold the rake and to lift it when the mass of roots is to be dropped. Two handles serve to lift it from the roots, as well as to make it run at the desired depth. Ordinary harrows will loosen the roots, but not bring them to the surface. The rake just described will haul them along to the row of roots, when they may be released on the top of the ground.

789. I have frequently heard farmers complain that they could never succeed in utterly exterminating this weed. The true reason of this is, as soon as the quack is so far subdued as to not retard growing crops, all effort to eradicate it is abandoned; and in a few months, during the former part of the growing season, the roots spread with astonishing rapidity. When it appears to be almost exterminated, then is the time, quite as much as at any other, to apply the hoe and the rake, and cut up, or pull up the last vestige of root and branch. This is the only way of effectual extermination.

BUTTERCUP—CROWFOOT.—(*Ranunculus Acris.*)

790. Botanists mention, besides the Ranunculus Acris, the White Water Crowfoot, (*Ranunculus Aquatilis*); the Yellow Water Crowfoot, (*R. Purshii*); the Sea-side Crowfoot, (*R. Rhomboidæus*); the Small-flowered Crowfoot, (*R. Abortivus*); the Cursed Crowfoot, (*R. Sceleratus*); the Hooked Crowfoot, (*R. Recurvatus*); the Bristly Crowfoot, (*R. Pennsylvanicus*); the Early Crowfoot, (*R. Fascicularis*); the Creeping Crowfoot, (*R. Repens*); and the Bulbous Crowfoot, (*R. Bulbosus*). A person will need a liberal smattering of botany to be able to distinguish the small botanical difference between these weeds.

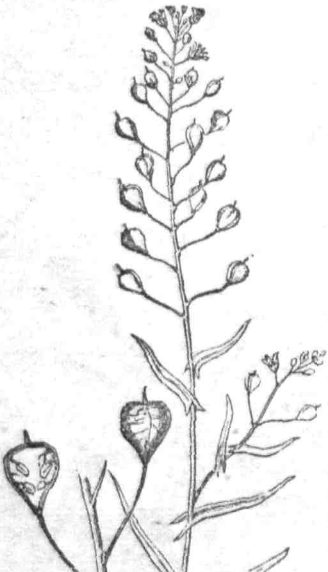
791. The *Ranunculus Acris* is a very pernicious weed. It appears abundantly in pastures and old meadows all over New England, Central and Western New York, Ohio, some parts of Canada, Pennsylvania and other States. It may be easily distinguished by its bright yellow flowers on the ends of tall stems. It is not a poisonous plant; cattle frequently eat the seeds and drop them on different parts of the farm, as was mentioned under the head of Daisies, par. 732. When the weeds are dried with grass for hay, the seeds are carried in the manure to cultivated fields.

792. Many farmers contend that this weed will make good hay, as animals will eat it with avidity. So they will eat burdock leaves, thistles, and other pernicious weeds found among hay, simply because they are fond of a variety. But such plants are unfit for good hay; and besides this, more than twice as many pounds of timothy hay will grow on a foot square as can be made of this weed. I know a farmer who kept a drove of cattle over night in the winter, and the animals left the seed of the *Ranunculus Acris* all over his meadow, in their droppings; and the second summer afterwards, the Crowfoot appeared in vast numbers.

793. Mow the grass where this weed appears, before it has matured the seed. Then plow the ground and cultivate a hoed crop, and follow this with spring crops for two seasons. This

plant is a perennial; therefore winter crops should not be raised where it exists until every plant is exterminated with Spring crops. (Read paragraph 730.)

FALSE FLAX—(*Camelina Sativa.*)



FALSE FLAX.

794. This noxious weed is an annual, which always springs from the seed in the former part of the growing season, and dies, root and branch, during winter. Many farmers insist that it is a kind of degenerate flax, which is no more probable than the theory of the transmutation of wheat to chess. This weed is not at all troublesome, if land is well cultivated, as a few heavy crops will choke and effectually exterminate it. Let none go to seed. Then, if the plants appear, the seed must be grown out of the soil, as directed for exterminating mustard or charlock, par. 759. Mow it when in blossom in pastures and meadows, and put it in heaps, and let none of the seed be scattered among manure.

FOX-TAIL GRASS.—(*Setaria.*)

795. There are two species of this grass represented by the illustration, which are so nearly alike that it is difficult to distinguish the difference, unless the plants are placed side by side. They are both annuals, and yield an abundant seed, which renders gardens, Indian corn fields, and some other cultivated ground extremely grassy. One seed produces sometimes forty or

more long seed-stalks, loaded with seed. After hoed crops have been dressed for the last time, tussocks of fox-tail grass frequently appear in great abundance, which are pulled up and twisted into bands for binding stooks and bundles of corn-stalks. In this way the seed is scattered among the manure and carried to cultivated fields. This kind of grass sometimes appears after wheat, oats and barley have been harvested, producing a heavy crop of seed before winter, when allowed to grow without interruption.

FOX-TAIL GRASS.

796. The best way to manage with the grass, when it appears after harvest, is to collect a large number of sheep into one field and let them eat it close to the ground. Should it appear again before winter, feed it off again. Or, as soon as the blossoms are formed, plow it all under, when the seeds will decay if they have not ripened. Every plant will die during the winter. Therefore it is only necessary to prevent any going to seed for a few seasons, in order to exterminate it effectually. When large tussocks are formed among Indian corn and potatoes, better pull

them and throw in large heaps, where seed and stems will decay, unless dead ripe, than to allow the seed to fall where it grew. This kind of grass gives more trouble, sometimes, than any other weed, in flower and vegetable gardens. In such places, hoe it up or let it grow till it appears in bunches, when it can be pulled up with little labor. It never gives any trouble on sod ground, as the cultivated grasses choke and supplant it.

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